ViStA

Video Streaming Alberta Project

# ViStA Project Final Report:

A Guide to Video Streaming Best Practices

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# 1.0 Executive Summary

The Video Streaming Alberta (ViStA) Project was initiated in December 2001 to define and develop a prototype for the effective delivery of digital video to school jurisdictions in Alberta. The project was defined by six key components: provisioning, multipurposing, installation, accessibility, networks, and implementation/use in the classroom. These components aimed to determine the short and long term pedagogical and technical requirements for the support of video streaming to schools and form the structure of this report.

With initiatives such as SuperNet and LearnAlberta.ca, ViStA project partners and collaborators foresaw a need to identify, investigate, and research the critical requirements for delivering video over high-speed networks. This would permit video delivery to meet or exceed the expectations of students, their families and educators in Alberta.

The results of this project will help to inform ongoing developments in learning technologies in Alberta. More importantly, they will provide answers and recommendations that will ensure the successful delivery of digital video to Alberta schools.

Various objectives were achieved and recommendations put forward by ViStA participants in each of the following component areas:

**Provisioning**

- Recommendations for rights management of licensed content in the LearnAlberta.ca portal, including rights standards overview, were made.
- Technical implications for the provisioning of digital video were identified.
- Common business models utilized in the provisioning of digital video were reviewed.
- Solutions to technical challenges included models that supported access to video resources for home use and models that allowed access to the same resources from schools and school jurisdictions.
- Digital rights secured for digital video should, as much as possible, include usage rights for downloading, segmenting, and customization to support student learning.

**Multipurposing**

- Specifications for metadata, technical and software standards/guidelines were identified.
- Specifications for the preparation of digital video for streaming were identified.

**Installation**

- The Alberta Learning Object Hub Application (ALOHA) indexing tool was refined for use with Alberta Learning's Learning Outcomes Database.

**Accessibility**

- A K - 12 user interface with search/browse capabilities built on Campus Alberta Repository of Educational Objects (CAREO) was designed and developed to inform the future LearnAlberta.ca portal interface.
- Usability testing to determine best practices related to the pedagogical and technical requirements for streaming video in Alberta were conducted and evaluated.

**Network**

- Streaming video over high-speed networks to schools in Alberta was tested.

**Implementation/Use in the Classroom**

- Recommendations for the successful use of video resources in the classroom were made.
- Prioritized recommendations for further investigation related to digital video and student learning were made.

## 1.1 OUTCOMES SUMMARY

The following is a high level summary representing some of the **outcomes** from the previously described objectives of the ViStA project:

**Provisioning**

1. Various business models/approaches (Section 5.2.4 Business Models) are utilized in the provisioning of digital video. Awareness of the models and corresponding digital rights (Section 5.2.5) and technical information (Section 5.2.3.1) is important for decision-making and acquisition of digital video.
2. The decision to standardize on a digital rights management language in early spring of 2003 is pre-mature given industry trends and commercial product availability. It is recommended that Alberta Learning continue to watch Object Relational Description Language (ORDL) eXtensible rights Markup Language (XrML) and industry leaders such as IMS (http://www.imsglobal.org/) and EduSource Canada (http://www.edusource.ca/) over the next year.

**Multipurposing**

1. An outcome of the ViStA project was a multipurposing specifications document for LearnAlberta.ca that could address media preparation (Appendix: Video Streaming Technical Implementation Guide).
2. Digital video created specifically for LearnAlberta.ca will use the Apple QuickTime format. Microsoft Media Player video may also continue to be acquired for delivery via LearnAlberta.ca. Specific guidelines and specifications are contained in Appendix: Video Streaming Technical Implementation Guide. These decisions have technical requirement implications for schools across Alberta. The Technology Standards and Standard Solutions (TSS) process will be used to maintain these specifications.
3. A stand-alone report addressing SuperNet, video streaming protocols, firewalls, and security is recommended.

**Installation**

Metadata specifications to describe learning resources, and tools to facilitate this task are necessary. The outcomes related to this work are summarized below:

1. Learning resources contained in LearnAlberta.ca will be described using a standard that emerged during the timeframe of ViStA; i.e., the Institute of Electrical and Electronics Engineers Learning Object Metadata (IEEE LOM) and include Alberta Learning Outcomes (Appendix: Metadata Guidelines for LearnAlberta.ca).
2. A usability study for the ALOHA metadata indexing tool (Installation Section).
3. A process was tested to attribute outcomes to learning resources: Alberta Learning Outcomes were shared via eXtensible Markup Language (XML) and data was displayed in ALOHA (Installation Section).

**Accessibility**[1]

For students and teachers in Alberta to easily retrieve video from the web, the following user interface details were found to be significant:

1. Browser features should be customizable upon user login to allow teachers and students to access relevant learning resources. This helps ensure that the search for and retrieval of relevant digital video resources is simple and based on grade, subject area and/or topics.
2. Elements such as software plug-ins, troubleshooting, testing tools, frequently asked questions (FAQs) and a user tour should be easily identified and accessible from the home page.
3. Students and teachers should be able to search for and access resources from the home page based on subject and grade level.

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[1] For the purposes of the ViStA project, accessibility is defined as *access* to digital learning resources via web-based user interfaces and features.

4. A “best guess” option to address misspelled search keywords should be provided. (i.e., “Could this be what you want?”).
5. The web site should provide for user preferences including: search options, language, best guess, tools, help, guided tours and demonstrations to ensure ease of use and to avoid zero results.
6. It is important to establish how students interact with various interfaces. In order to ensure the student learning experience is positive, students from each of the Divisions I – IV tested both the ViStA static and dynamic interfaces. Recommendations and observations from each level were collected for input into the design of these interfaces. Results included changing icons, colours, fonts, wordings, how the search worked, etc. These recommendations will result in modifications to the interfaces that maximize their usability at each of the different levels.

Student recommendations resulting from the field tests of static and dynamic interfaces are detailed in Section 5.

**Network**

High speed network access to all schools in Alberta presents many opportunities and challenges. Much of the area of video streaming is based on emerging technologies that are not yet fully developed. SuperNet deployment in Alberta required testing on a high-speed network to ensure that video could be streamed from the source to the classroom desktop. Isolated SuperNet tests were performed although a full “real world” test of delivering video over SuperNet was not performed.

It is recommended that further testing be conducted to ensure the successful delivery of video over SuperNet. Many factors including jurisdictional network quality of service (QoS), security, and content prioritization that will influence the number of video streams that can be delivered over a 5 Mbps or higher SuperNet connection require further testing.

**Student Learning**

Implementation issues are captured, to a certain degree, in the usability studies summarized in the accessibility component above. Investigation regarding use of LearnAlberta.ca digital video learning resources in the classroom was affected by the lack of a capable delivery network for digital video. Guidelines for the creation and local use of digital video to support curriculum outcomes can be found in Section 5.8.

Further investigation and research in the use of digital video *in the classroom* is required including: applicability of short video clips, usability in various learning environments, effectiveness, and so on. Survey results from ViStA indicate that 65% of students surveyed believed that short digital video clips would be useful for learning. Some implementation questions are partially addressed in the Appendix: Literature Review (a literature review related to the educational use of digital video).

Several important questions related to digital video and student learning require further investigation. They include customization of digital video by students and staff, whether digital video resources complement activities in the classroom and other learning settings, and so on. The questions are outlined in a prioritized list in Section 5.

**Conclusion**

The findings of this project suggest that streaming video to schools in Alberta is of interest to many parties across Alberta's learning community. Recommendations suggest that more pedagogical research and technical testing in various learning contexts is needed upon the full deployment of SuperNet. As video streaming becomes more prevalent in Alberta classrooms, it is suggested that alternative methods of streaming delivery be investigated to address potential bandwidth saturation issues. Continuing to review media preparation and metadata specifications is important from a usability perspective.

In order to maximize educational and financial value, business models and approaches for licensing streaming video for use in education must evolve along with the technology and the nature of how video is used. Those responsible for licensing materials will need to understand the fundamentals outlined in this report and innovate in order to meet business and educational needs. Monitoring international standards and industry trends will also inform decisions for correlating Alberta learning outcomes and handling digital rights management in the future.

## 2.0 A Guide to the Final Report

This report is intended to inform stakeholders, participants and partners of the purpose, investigations, results, best practices and recommendations that have emerged from the Video Streaming Alberta project. The reader is provided definitions, background, and lessons learned related to the provisioning, multipurposing, indexing, installing, delivery and classroom implementation of digital video from online sources. The appendices provide further details, specifications and procedures.

# 3.0 Project Purpose and Background

## 3.1 PURPOSE

The Video Streaming Alberta (ViStA) project was launched in December of 2001 to:

> "Define and deploy a prototype for the effective delivery of recently licensed and existing digital video to selected publicly funded school jurisdictions. The information gathered during the development and deployment of this prototype will determine the short and long-term pedagogical and technical requirements to support video streaming to schools and homes.
>
> More globally, ViStA will inform the future development of the LearnAlberta.ca portal, an Alberta Learning project. The long-term goal of the LearnAlberta.ca project is to support lifelong learning by creating a digital learning environment for all Albertans. The initial focus is the K-12 learning community."

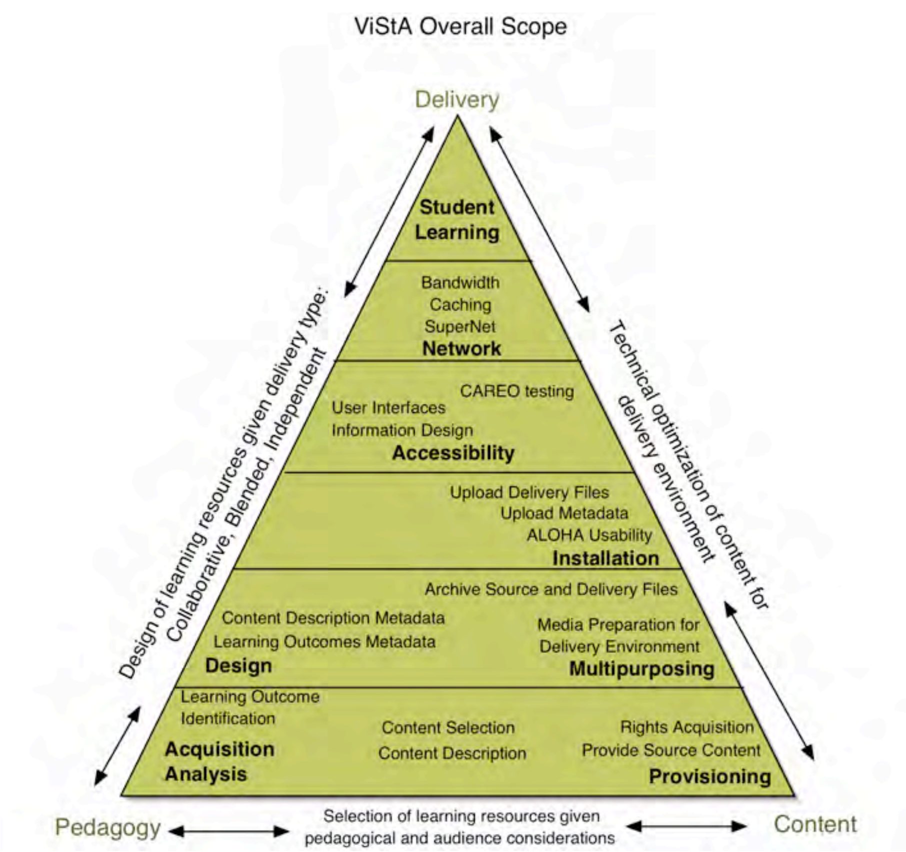


**Figure 1: ViStA Overall Scope**

The ViStA project attempted to build on the experience of various partners and projects by investigating issues related to streaming video (see Background Information and Project Partners sections). An underpinning assumption of the project was that innovative methods of video delivery could enhance the teaching and learning process. The Internet and streaming technologies offer unparalleled access to resources such as digital video. Investigations of technical, functional, and pedagogical issues were required to enable access to a vast repository of video segments targeted and correlated to the Alberta Learning Program of Studies.

With a holistic approach to this process, from the selection and acquisition of video content to its delivery into the classroom, the ViStA project focused on the interaction between three aspects of digital video delivery:

- Pedagogy
- Content
- Delivery

This interaction is modeled in Figure 1. **Pedagogy** refers to the process of selecting appropriate learning resources for an identified audience using a variety of instructional models. **Content** pertains to the technical preparation of digital video, rights acquisition, standardized metadata, archiving formats, installation of specialized servers, application of standardized metadata, and technical delivery considerations. As the model approaches **Delivery** items such as web access, graphical user interface, and usability give way to networks, servers, and bandwidth, and ultimately to use in the classroom and student learning. Pedagogy, content and delivery aspects must match the needs of learners and teachers to support classroom implementation.

The scope of the project is comprehensive, covering the complete supply-chain for using digital video to support learning and teaching. The supply-chain, or process including pedagogy, content and delivery, is as follows:

1. **Provisioning** of learning resources refers to the analysis of the intended audience, their needs and the correlation of the resource to the learning outcomes. It also refers to content selection, description and acquisition.

   Section 5.2 outlines detailed information related to provisioning and Appendix: Video Streaming Technical Implementation Guide includes best practices.

2. **Multipurposing** of acquired content refers to the optimal preparation of the video for the delivery environment, including indexing for search and retrieval, correlating to the Alberta Learning Program of Studies (or curriculum), and archiving.

   Section 5.3 and the Appendix: Video Streaming Technical Implementation Guideline include specifications for media preparation and indexing, best practices, lessons learned and detailed information related to Multipurposing.

3. **Installation** of digital video refers to the preparation and installation of files, including the metadata, on specific servers using specialized tools.

   Section 5.5 includes usability information for the indexing tool Advanced Learning Object Hub Application (ALOHA).

4. **Accessibility** pertains to the user environment in which learners access digital video over the World Wide Web including web user interfaces, search engines, browse functionality, and information design.

   Sections 5.6 and the Appendix: Interface Evaluation Report provide information related to the usability, functionality and supportive interaction when retrieving digital video.

5. **Network** pertains to technical issues such as network, bandwidth, SuperNet testing, and other considerations like caching and video servers.

   Section 5.7 and Appendix: SuperNet Testing Results outline network considerations and specifications resulting from this project.

6. **Student Learning** is where technical, pedagogical, and content related aspects come together to support teaching and learning.

   Section 5.8 includes a best practice guide on how to implement digital video resources in the classroom.

## 3.2 Project Background

### 3.2.1 Overview

In November 2000, the Alberta Department of Innovation and Science announced the SuperNet - a $300 million dollar investment to bring equitable high speed Internet access to all remote, rural and urban Albertans. SuperNet connectivity to 422 communities in Alberta is slated for completion by Fall 2004 (http://www.albertasupernet.ca).

At approximately the same time, Alberta Learning was planning for the delivery of digital learning resources to students, parents and educators across the province using the proposed SuperNet infrastructure. This project to develop, acquire and license digital learning resources became known as the LearnAlberta.ca project (http://www.learnalberta.ca).

The planning process for LearnAlberta.ca included the initiation of smaller projects such as a physics video pilot in 1999. In conjunction with various school boards and Netera Alliance, the Alberta Physics Learning Enhancement Group (APLEG) conducted a number of preliminary tests using existing Internet capabilities. This work concluded that best practices for use in an educational setting had not been established. The potential for costly mistakes during larger scale implementation across Canada was substantial.

Other related activities are outlined below. The ViStA project was initiated to further investigate video streaming and to address issues raised through these activities.

### 3.2.2 History of Related Activities

#### *3.2.2.1 Central Alberta Media Services (CAMS)*

http://www.cams.ab.ca

CAMS currently hosts a members-only web site that allows members to browse and order titles from the CAMS media catalogue. CAMS's video streaming research project committee assesses the feasibility of streaming titles in their catalogue to schools throughout the province. Although prohibitive costs disallow such a service at this time, the committee is staying abreast of various projects including ViStA and SuperNet to help them make informed decisions about future directions.

#### *3.2.2.2 Video Online Curriculum Repository in Alberta (VOCRA)*

http://www.tutorbuddy.com/tby1/newsite/pilot.php

In the spring of 2001, Tutorbuddy Inc. was established by Magic Lantern Communications Ltd. (MLC). Tutorbuddy aimed to deliver searchable, curriculum-correlated video and learning objects to schools via the Alberta SuperNet. The VOCRA pilot program was initiated to examine Tutorbuddy within a school context. The program ran from April 17, 2001 to May 30, 2001 in 11 Alberta schools.

The pilot program was designed to test three potential Tutorbuddy services:

1. Video-on-Demand (VoD) – A system where teachers and learners log onto Tutorbuddy over the Internet to access streamed video content.
2. Content Management Expert (CME) Service – An added feature of the video-on-demand service which made a teacher available online to provide tutoring and other assistance to online learners from within a chat room.
3. Service to Virtual Schools – Virtual schools were given the opportunity to test the Tutorbuddy application for distance learners.

The Learning Technologies Branch played an essential role in facilitating VOCRA by providing licences for digital rights to more than 100 Magic Lantern Communication videos. Titles from Alberta Learning were also provided for the project through ACCESS. In turn, VOCRA supported the development of the LearnAlberta.ca project by sharing the findings of the VOCRA project. Recommendations indicated that the use of online video was beneficial for teaching and learning.

MLC, Alberta Learning and ACCESS sponsored an independent external evaluation of the VOCRA Project (report is available from west@magiclantern.ca.).

#### *3.2.2.3 Calgary Board of Education Streaming Media Pilot*
http://www.cbe.ab.ca

In April and May of 2001, the Calgary Board of Education (CBE) ran the Streaming Media Pilot in parallel to the VOCRA streaming video pilot in an effort to enhance data collection methods. The primary goal of the CBE's participation was to "assess the educational value and technical feasibility of using streaming video for enhancing teaching and learning within the Calgary Board of Education."

Prior to the VOCRA project, Alberta Learning had secured rights from Magic Lantern Communications for streamed versions of the physics videos "Mechanical Universe" and "Beyond the Mechanical Universe" as well as a number of associated learning objects that were developed during this project.

Two CBE teachers reviewed the physics materials and developed a number of online instructional resources including learning activities and self-assessment tools. These resources were incorporated into a web-based learning environment built around existing resources from LearnAlberta.ca.

Different technologies and networks were used "to test the internal technical and conceptual issues of operating a dedicated video streaming server behind a corporate firewall. The tests were designed to model and investigate the methods by which the CBE might use LearnAlberta.ca resources."

#### *3.2.3.4 Edmonton Public School Board*
http://www.epsb.ab.ca

United Streaming, a large U.S. video resource company has assembled a large collection of educational videos including resources developed in Alberta by ACCESS. Edmonton Public Schools acquired a license from the Canadian distributor, Waynor Media Solution, in order to test the product in selected schools. Eight Edmonton Public Schools embarked on a pilot project between June 2001 and January 2002. The schools included four elementary, one junior-high, one junior-senior high and two senior high schools. The schools are located in different parts of the city and vary in terms of their technological infrastructure.

The data collected as part of the study consist of teachers' opinions based on their experiences with the product as well as technical information collected by the administration such as frequency of access, choice of videos and the extent to which the streaming was successful.

There were significant variations in terms of the curriculum outcomes covered by the United Streaming product. Teachers of elementary and junior high schools found that there was good support for mathematics, music, health, science and some parts of elementary social studies (i.e., China and Ancient Greece). On the other hand, the weak areas for these levels were language arts and social studies and junior high physical education. At the high school level the support for science, particularly biology, and CALM were found to be good while mathematics, English, social studies and physical education were considered to be weak. It should be emphasized that social studies at all levels lack Canadian content.

There was consensus among users that the interface including the search capacity need to be improve and become more user friendly, attractive and useful. Notwithstanding this comment, the fact that each video is divided into a number of segments enables the teacher, once they find the right video, to effectively search for the chapter and use the short segment to reinforce and illustrate concepts taught. Teachers found the technology of video streaming to be more useful, flexible and effective than the traditional videotape. The activity sheets that accompany many of the videos were generally thought to be good and useful in class situations. Teacher guides, black line masters and post tests also proved to be valuable. The scripts were particularly helpful to the learning impaired interpreters. Teachers also emphasized the benefit of providing students with access to the material from any computer linked to the Internet and commented on its usefulness in the development and delivery of individualized or web-based modes of instruction.

A lead teacher was identified in each school and additional teachers were involved with the use of the video-streaming product. The range of titles used in any one school is in part a function of the courses the teachers using the product were teaching. The most popular topics for teachers were mathematics, biology, history and geography. In general, the video streamed material was considered to be very valuable and supplementary to the range of resources available to teachers.  Schools would be willing to pay a reasonable fee in order to access.

The major factor limiting the use of the product by teachers was the inconvenient access in the classroom. The use increased with the availability of appropriate technology such as an upgraded computer, television with a video card and a projector.  The technical review of this technology suggested that the current technology available in most schools would be sufficient to access the United Streaming product. It consists of appropriate workstation (minimum of Pentium II, with 400 MHz and 128 KB RAM), software (Windows Media Player 7.1) and network (the Virtual Private Network currently connecting all schools to the Wide Area Network and 100 Mbps connection within the Local Area Network). Video streaming will have a negative impact on the bandwidth available for other purposes. Under these conditions, the number of simultaneous users should be limited to ensure a fast response time.

The respondents indicated that the level of technical expertise required at the school is within reach of the schools, whether through Information Technology Services, school staff or other acquired service. The available local technical support was not able to address concerns related to connectivity to a remote server. It is vital that schools experience a higher rate of success in their attempt to stream videos. Our findings suggest that only 56% of the connection attempts were successful and the success rate among schools ranged from 40% to 86%. The success rate was not associated with the bandwidth available to the various schools but to the timing of the attempt to video stream. The reliability was significantly higher during non-peak hours (80-90%) than during peak hours (50-65%).

In summary, while there was a recognition among teachers who used the videos that their quality was high, it was clear that an interface that is more user friendly is desired and that the correlation to the Alberta curriculum will significantly enhance its relevance to the classroom teacher. Furthermore, the issue of enhanced connectivity must be addressed if the teachers are to feel that this technology is reliable.

#### *3.2.2.5 Bishop Caroll High School (BCHS)*

http://www.bchs.calgary.ab.ca/

In October of 1999, Bishop Caroll High School was approached by the Learning Technologies Branch (LTB) of Alberta Learning to participate in a streaming video project that would allow the school online access to physics video segments. According to David Paraschuk, Coordinating Teacher, "the video-streaming-on-demand, the main feature of the project, became reliably available in early February [2000]." The students at Bishop Caroll have been using the video-on-demand resource since that time. He suggests that the program is well received by students:

> "Students have reacted very favorably to the introduction of this resource into their regular program of studies. I have documented examples where students would come to me and indicate that they had many questions about concepts to be learned in a given unit. After taking time to view the physics video clips associated with the units, the students have often said that all their questions had been answered… At this point the majority of the students in the physics program at Bishop Carroll are using this resource on a regular basis."

To supplement the program, Alberta Learning developed a series of interactive tutorials using the video clips as a basis for students to explore physics concepts in depth.

#### 3.2.2.6 Cascading Server Project

http://repliweb.com

The Cascading Server Project focused on replication and mirroring of data using tools such as Repliweb (http://repliweb.com/). Findings of the project suggest solutions for file distribution, although the project did not focus on video streaming or video delivery. No final report was created, but this project lead to several others including ViStA and the Bandwidth Estimator.

#### *3.2.2.7 Literature Survey*

Appendix: Literature Survey

Karen Slevinski (Alberta Learning) conducted a survey of the literature surrounding video streaming in online education and in the regular classroom. Her survey includes the following conclusions:

> "Studies have repeatedly shown that technologically-rich opportunities increase student learning, performance, technical skill and communication. Incorporating streaming media technologies into online courses and connecting students to high speed Internet access can help students visualize difficult concepts, interact with their professors and each other, learn quicker, develop positive attitudes to learning, derive increased satisfaction with learning, have increased motivation and interest in learning, and derive greater enjoyment from learning. One study even indicated that properly developed courses with streaming media can increase student retention. Positive results were obtained even when low quality streaming and low bandwidths were available to students.
>
> Development and delivery of quality online courses requires a support system. Repeated studies also indicated that technological difficulties and lack of appropriate technological skills were major barriers. If there are too many technological difficulties associated with streamed multimedia course development, then it will get a bad reputation. This will unnecessarily delay the potential benefits of multimedia enhanced online courses."

#### *3.2.2.8 Rural Advanced Community of Learners Project (RACOL)*

http://www.racol.ualberta.ca

The goal of the RACOL project is to develop a model of teaching and learning that exploits the potential of broadband networks and advanced technological capabilities such as broadcast quality video and educational objects to create effective learning environments that address the needs of students in rural and remote school districts.

A first step of the RACOL project has been the development of an advanced broadband asynchronous/synchronous distance education system to facilitate quality and equitable learning experiences for K-12 students in the Fort Vermilion School Division (FVSD).

Virtual Presence Learning Environment Systems (VPLE), which are based upon the concept of providing multi-point MPEG-2 broadcast-quality video and audio to and from all locations, have been installed in six communities up in the Fort Vermilion School Division and these audio/video systems are currently being used to teach Math, Science, Physics, CALM and Aboriginal Studies.

RACOL is making use of advanced network technologies in Alberta to support the delivery of digital video over the Alberta SuperNet, NeteraNet and CA*Net4.

In the recent implementation of the VPLE systems in Fort Vermilion, the SuperNet network was tested for QoS service levels by transferring a 10 Gigabit file over the network while delivery a 3 point multipoint MPEG2 videoconference. All three sites connected in the videoconference experienced no fluctuation in quality in video and audio while the file transfer took place.

The RACOL VPLE environments support not only the multipoint delivery of curriculum in real time, they also capture and archive all live sessions, which are automatically rendered into QuickTime videos available for asynchronous delivery over SuperNet to further support students with their distant learning needs. Networked technologies also introduce collaborative partner classrooms from around the world including university faculty, and practitioners from the community.

RACOL is the result of collaboration between the University of Alberta, the University of Calgary, the Banff Centre, Sonic Design Incorporated, the Northern Alberta Institute of Technology (NAIT), Netera Alliance and the Fort Vermilion School Division (in conjunction with the Meander River Dene Tha First Nation School).

Results from the RACOL project will help to further inform the Vista report related to the delivery of digital video in both synchronous and asynchronous formats over SuperNet, NeteraNet and CA*Net4.

# 4.0 Project Description and Management

## 4.1 GOVERNANCE

### 4.1.1 Steering Committee

A Steering Committee (comprised of one representative each from Netera Alliance, ACCESS-LTA, and Alberta Learning) provided overall project management, day-to-day direction, financial administration, communications, and technical infrastructure support to ensure project success. The Steering Committee met approximately every two weeks to ensure timely decision-making, ongoing communications with partners, and adherence to the work plan.

### 4.1.2 Working Groups

Working Groups (comprised of representatives from each partner group and individuals invited on an as-needed basis to contribute relevant expertise) were tasked with meeting project objectives under a working group lead and with direction from the Steering Committee.

This original governance structure was adapted over the course of the project. The Steering Committee membership was informally enlarged to include specific leads of the working groups as needed.

The Content Working Group met several times in February and March, 2002. This team, comprised of Alberta Learning, CAREO/ALOHA and ACCESS-LTA staff, took the lead in many of the project activities involving provisioning, installation, multipurposing, accessibility and indexing.

The Network Working Group held three initial meetings and provided direction for some aspects of the planned testing.  The team was comprised of Netera Alliance, Alberta Learning, Chinook's Edge School Division, Black Gold School Division, Grande Yellowhead School Division, Palliser School Division, Elk Island School Division and Wild Rose School Division. The group aimed to conduct "real world" tests over SuperNet to ensure that video streaming measurements where taken amid other Internet and learning data traffic. Testing of video traffic over SuperNet occurred in late fall 2002. While it was not possible to simulate a complete "real world" network environment for this project, a network infrastructure with video traffic was tested.

The Network Working Group was re-convened in early February 2003 to conduct additional SuperNet testing (commenced in January 2003).

The Evaluation Group was comprised of staff from the Academic Technologies for Learning Unit at the University of Alberta with coordination provided by Alberta Learning staff.

### 4.1.3 Project Organizational Chart

The chart below outlines the organization chart of the ViStA project:

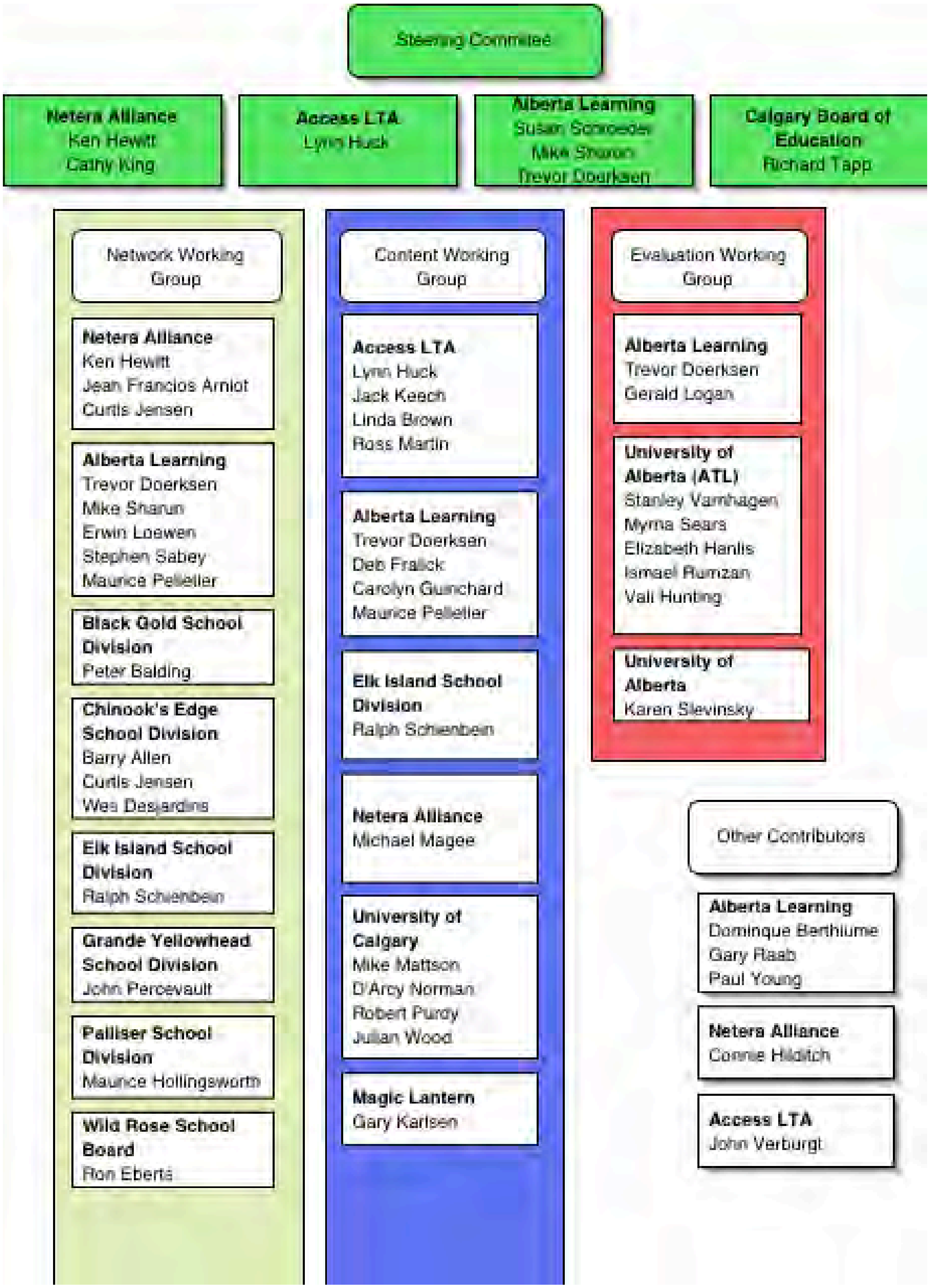


**Figure 2: ViStA Organization Chart**

### 4.1.4 Objectives and Accountability

Objectives and areas of accountability were identified for each party as follows:

ACCESS-LTA:

- Compile video materials (i.e., ACCESS-LTA, National Geographic, Magic Lantern, United Streaming).
- Facilitate rights management (ensure intellectual property rights were secured for the intended audience).
- Index and meta-tag digital video in collaboration with Alberta Learning.
- Coordinate content loading and video formatting in collaboration with Alberta Learning.
- Ensure communications and announcements to partners and the public were timely and informative.

Netera Alliance:

- Provide overall project management.
- Integrate required technical components to deliver streamed video, including:
    - jurisdictional technical architectures
    - video server technical operating environments
    - network interfaces, including commercial Internet, SuperNet and NeteraNet.
- Provide financial administration and facilitate internal communications (web site, timesheets, deliverables and project database).
- Produce reports and perform/compile research.

Educational Partners:

- Provide technical and educational expertise.
- Provide interface with schools.
- Participate in focus groups, tests, and evaluations.
- Participate in the development of guidelines and documentation.

Research and Development Partners:

- Provide technical and educational expertise.
- Provide tools and custom development for project deliverables.
- Participate in the development of guidelines and documentation.

Industry Partners:

- Provide technical expertise.
- Provide tools and custom development for project components.
- Participate in the development of guidelines and documentation.
- Promote sustainable opportunities for project components.

Alberta Learning:

- Ensure overall alignment of ViStA with developing priorities and directions.
- Coordinate with other provincial activities.
- Provide technical and educational expertise.
- Provide tools and custom development for project deliverables.
- Participate in the development of guidelines and documentation.

## 4.2 PARTNERSHIPS

The ViStA project included the following stakeholders from the learning sector:

### 4.2.1 Alberta School Jurisdictions

Alberta school jurisdictions were included to represent the user community, especially those involved in early SuperNet deployment discussions. The following jurisdictions provided input for this project:

- Black Gold Regional Division #18
- Calgary School District #19
- Chinook's Edge School Division #73
- Edmonton School District #7
- Elk Island Public Schools Regional Division #14
- Fort Vermillion School Division #52
- Grande Yellowhead Regional Division #35
- Palliser Regional Division #26
- Wild Rose Division #66

### 4.2.2 Industry Partners

Industry partners were included to represent suppliers of services and/or learning content. These partners included:

- Axia SuperNet
- Callisto/SUN
- Magic Lantern – TutorBuddy
- Telus

### 4.2.3 Post-Secondary Institutions

Post-secondary institutions were included because of the role they have played in developing e-learning infrastructure. The following institutions were included in this project:

- CANARIE (BELLE project)
- University of Alberta, Academic Technologies for Learning

- University of Calgary, Learning Commons

## 4.3 Work Plan

ACCESS-LTA and Netera Alliance were contracted by Alberta Learning to manage the ViStA project. The three groups developed a "Partnership Approach Document" to provide a more detailed work plan to guide the project. This work plan divided the tasks into six "theme" areas:

- Content Provisioning - Creating, acquiring and archiving video content.
- Content Multpurposing - Capturing, encoding and indexing video content.
- Content Installation - Uploading prepared content to appropriate "learning object repositories" (i.e. video servers).
- Content Accessibility - Designing appropriate user interface(s) and associated data models.
- Content Delivery - Implementing real network tests over SuperNet, comparing network performance in different scenarios, and evaluating the results.
- Evaluation - Evaluating user interfaces in real student interaction scenarios and under different network configurations.

## 4.4 Budget

Alberta Learning issued grants to each institutional partner that would incur direct expenses for the project. These grants were based on the overall project budget developed and approved by the Steering Committee. In addition to these contracts, school jurisdictional partners were sent letters of agreement authorizing reimbursement of direct expenses, up to a pre-set limit.

Original contract terms were to June 30, 2002, with subsequent extensions to December 31, 2002, and, for the networking component, to March 31, 2003. The total project budget was $230,020 with specific budget allocations to the following partners:

| Partner | Budget |
|---|---|
| Netera Alliance | $94,020 |
| ACCESS-LTA | $18,500 |
| University of Calgary | $10,000 |
| University of Alberta | $10,000 |
| Industry Partners | $20,000 |
| Educational Partners | $57,500 |
| CAREO | $20,000 |
| **Total** | **$230,020*** |

**Table 1: ViStA Budget**

* Alberta Learning funds were matched by Canarie through the BELLE and EduSource. Projects involved Netera, University of Calgary, Athabasca University, and the University of Alberta.

Since most expenses were covered by the pre-paid grant amounts, costs were reported to Netera for information purposes only. In turn, Netera prepared periodic financial reports for the Steering Committee.

## 4.5 Schedule

### 4.5.1 Overview

It was anticipated that the ViStA project would be completed in approximately seven months and would occur in two phases as follows:

- Phase 1 - The *start-up* phase was intended to confirm procedures, identify data requirements, develop communication processes, and identify outstanding technology concerns. This phase supported a video streaming trial using content from a single content provider, and involved only two to three video server options. It was to follow the build of SuperNet and involved three educational partners.
- Phase 2 - The *expansion* phase was to expand the prototype by involving additional educational and commercial partners.

### 4.5.2 Schedule of Events

| Date | Description | Location |
|---|---|---|
| December, 2001 | All-participant meeting to launch the project and receive preliminary feedback. | ACCESS-LTA |
| January, 2002 | Technical group meeting #1 | Alberta Learning |
| February, 2002 | Content group meeting #1 | ACCESS-LTA |
| Feb 2002 – Jan 2003 | 22 Steering committee meetings | Teleconference |

| | | |
|---|---|---|
| | approximately every 2 weeks | |
| February, 2002 | Segment 7 meeting consisting of 3 school jurisdictions, the U of C and Axia. | Axia Offices |
| Feb 2002 – Apr 2002 | 6 content group sub-meetings | N/A |
| June, 2002 | Benchmark tests | Will St. Clair HS, Rocky Mountain House |
| June, 2002 | All-participant meeting | U of C |
| July, 2002 | User interface tests | Devonian Building, Edmonton |
| August, 2002 | User interface tests | Grande Prairie |
| September, 2002 | User interface tests | Innisfail |
| September, 2002 | User interface tests | Tom Baines School, Calgary |
| October, 2002 | First video stream to SuperNet | H.J. Cody HS, Sylvan Lake |
| November, 2002 | All-participants meeting | ACCESS-LTA |
| December, 2002 | SuperNet streaming tests | Cody High School, Sylvan Lake |
| April, 2003 | All-participants final meeting to discuss project outcomes and report | ACCESS-LTA |

**Table 2: Project Schedule**

## 4.6 COMMUNICATIONS

Communication and reporting tools were employed to support the ViStA project. Internal communications (among project participants) were the main focus. External communications (beyond the project participants) were minimal. Communication methods included:

- E-mail listserv - This was for all ViStA participants. Transactions were archived on the ViStA web site.
- Web Site/Public database - Provided general project information and links to the larger context of LearnAlberta.ca. This database included a document archive.
- Periodic electronic newsletters - These newsletters were distributed via the listserv and also posted to the ViStA web site.
- Teleconferences – These were primarily used by the steering committee, the work groups, and for evaluation meetings throughout the project.

The listserv, electronic newsletters and web site facilitated the sharing of ideas and discussion throughout the ViStA project. They helped keep the ViStA steering committee informed to assist in their decision making.

## 4.7 CHALLENGES

Certain components of the ViStA project relied on external vendors and variables. These dependencies affected the fulfillment of some project deliverables. Specific project challenges are outlined below.

### 4.7.1 SuperNet

A major component of the ViStA project was the network testing which was dependent on scheduled completion of selected SuperNet segments. It became clear early in 2002 that the SuperNet rollout would not permit a "real-world" test until late in 2002. Due to the scale and complexity of the SuperNet construction, the segment intended to be used for the video streaming test was not operational within the timelines of the project. Benchmark tests were conducted in lieu of a test using the SuperNet segment.

### 4.7.2 Access to Schools

Gaining access to schools to conduct research, testing, and focus groups presents challenges. Ethics approvals to conduct research and focus groups must be obtained. This is a lengthy process. Teacher and student schedules are busy and limited in their flexibility. Approvals from school board IT staff are required to do network testing and to gain access to people and facilities such as labs. Busy schedules, lack of availability or flexibility, distance, and policy all impact access to schools. ViStA participants established strong communications and positive relationships with each other to help facilitate access to schools. □

## 4.8 Lessons Learned

Management of the ViStA project was complex due to the large number of individuals and organizations involved. Regular communications via the ViStA list serve, working groups and regular steering committee meetings provided a forum for project decision making. Under the guidance of educational stakeholders and content specialists, ViStA was able to carry out most deliverables.

From the perspective of project management, lessons learned related to both challenges and successes as follows:

- A small core project team proved very beneficial for project decision making.
- Effective communications were essential for involving all partners in the project.
- Including strong content area specialists and individuals with experience in video streaming helped to achieve the project deliverables.
- Alternatives were sought to gain access to schools and students for ViStA usability testing. Coordination and team-work ensured the successful completion of usability testing with a variety of students around Alberta.
- Access to telephone conference capabilities was important to project communications.

# 5.0 Video Streaming Best Practices

## 5.1 Overview

Over the past year ViStA has gathered, tested and evaluated video streaming scenarios and configurations. Students from the K – 12 sector played a major role in the testing and evaluation of interfaces and video streaming aspects of the project. ViStA also explored technical requirements and network feasibility for provincial school districts to discern effective and reliable methods for delivering video and digital resources to the classroom and to the desktop.

## 5.2 Provisioning

### 5.2.1 Definition

Content provisioning is the process by which digital learning resources are created, acquired, and archived for future use. For the purposes of the ViStA project, this translated to the gathering of video resources licensed for use by Alberta Learning to deliver to schools via the SuperNet.

### 5.2.2 Background

The following information outlines the lessons learned through the process of acquiring video content for the ViStA project and summarizes best practices for producing and acquiring intellectual property rights for streaming video. It provides a general guideline for Alberta Learning project coordinators, team members and other stakeholders involved in providing video content for LearnAlberta.ca.

However, it is important to note that the use of video for digital delivery is relatively new and industry precedents and standards have not yet been fully established. Issues surrounding storing, manipulating, accessing and delivering digital video continue to emerge while the management of rights and permissions of use that protect intellectual property in a computer network environment continue to evolve. Given the nature of solutions to specific challenges in reaching schools and homes with digital video, content vendors raised concerns regarding the business models, and access and security controls for students, parents and teachers.

Solutions to technical challenges should include models that support home use and models that allow content providers access to schools. Best practices will continue to change and will be influenced by legal issues surrounding protection of digital information, emerging technical capabilities and developing business models.

### 5.2.3 Best Practices

Best practices for content provisioning address two major concerns. The first is the ability to *acquire* relevant and technically compatible video for streaming. The second is the *acquisition of licenses* for those video segments so that they can be legally shown to students and others in the learning system. A background knowledge level is required to make informed decisions about the types of video to be acquired, the types of licenses required for their intended uses, and conditions surrounding both of these processes.

#### *5.2.3.1 Video Acquisition Checklist*

A number of conditions and recommendations for acquiring the most relevant and technically compatible video for use in the ViStA project were identified. These apply to future streaming video resources that are either developed or acquired. The following checklist is a compilation of technical criteria that should be used when acquiring digital video:

<u>Producing and Editing Source Files</u>

For video produced exclusively for Alberta Learning, the following materials should be retained:

- Raw footage (i.e., BetaCam, DVCam, etc.).
- Sound and voice-over materials (i.e., tape or digital files).
- Video editing application files (i.e., Premiere, Avid, Final Cut Pro, etc.).
- Layered graphics files (i.e., unflattened PhotoShop, Illustrator, etc.).
- Edit Decision List files (EDLs) (i.e., CMX, GrassValley, Sony or Generic).
- Miscellaneous media files (i.e., FX files, animations, Flash pieces, etc.).

<u>Capture Source Formats</u>

Alberta Learning should capture source formats that are high quality masters of finished video productions. Initial digitization would be derived from this format. For example:

- Analog video tape (i.e., BetaCam SP, SX, Digital (not VHS))
- Digital video tape (i.e., DVCAM, MiniDV, Digital 8)

<u>Transcoder Files</u>

Alberta Learning should transcode files that are high quality digitized versions of the video masters. For example:

- MPEG-2, I-frame format at a 10 Mbps data rate.
- DV (must fit on the storage media).
- Storage media (CD-ROM or DVD ROM disk).

- Standardized file naming convention (e.g., filename_tran.mpg or filename_tran.dv).

***5.2.3.2 Video Licenses***

Once the appropriate video materials have been identified, a license must be negotiated to obtain the rights to legally show the video to designated parties.

<u>*Basic* Video Licensing Rights</u>

The initial step in negotiating a licence for the use of video is to establish the manner in which the material is going to be used. This is to ensure that the secured rights meet the needs of the intended use. Rights commonly addressed in *standard* video licensing agreements include:

1. **Territory of use** (i.e., Alberta, Canada, world-wide)

   When negotiating a licence agreement, it is desirable to secure world-wide rights in perpetuity. Licensing world-wide rights eliminates the need to restrict access from users residing outside the licensed territory.

2. **Time period of use** (i.e., 4 years, in perpetuity)

   Securing rights in perpetuity allows continued use of the material until it becomes outdated or is deemed no longer relevant to the course of study.

3. **Type of use** (i.e., broadcast, duplication, online use, CD-ROM etc., educational, home, commercial, etc.*)*

   *Type of use* refers to the mode of distribution and the market in which the materials are to be distributed. For example, Alberta Learning could license rights to broadcast, duplicate (video) and stream a specific video title within the educational sector in Alberta. Translation into another language would be considered to be a *new* use to the license.

4. **Frequency of use** (i.e., number of plays, one time use for one specific project, limited quantities, unlimited use, etc.)

   *Frequency of use* is often specific to the type of use. For example, when acquiring a title for broadcast, the number of times the video is aired is negotiated as part of the licence agreement. A licence with duplication rights may either restrict the number copies to a specific quantity of duplications or grant permission for an unlimited number of copies.

Rights place limits on how and where an acquired video may be used. It is desirable to license a video for world-wide use, in perpetuity for all modes of delivery, including electronic and digital transmission. The broader the scope of rights negotiated the more flexibility for use. Often such rights result in higher licensing fees. At a minimum, the rights secured must be sufficient to ensure the content can be used in the manner for which it is intended.

*Other* Video Licensing Rights

When licensing digital video, content provisioning (segmenting or indexing), multipurposing (encoding in various formats and bit rates), distribution, excerpting (disassembling the original work) and downloading rights need to be addressed with the content provider. These are in addition to the rights previously noted.

1. Segmentation or Indexing Rights

   Often an entire video is not required to meet the intended use. It is beneficial to secure the right to segment or divide into smaller pieces the licensed video footage. It is also important to determine whether the provider can supply the content segmented with indexes. Video segments should be reviewed prior to licensing to ensure the segmenting meets Alberta Learning requirements. If not, permission to segment or index should be included in the licence. Vendors will usually grant these rights as long as the “complete” program (including credits) is available for viewing at all times.

   If segmenting is to be completed by staff, time and resources are required in the budget to complete this work. Staff sufficiently familiar with editing video are required for these tasks. The time required to complete the segmenting should be considered when negotiating the *commencement date* of the licence. If agreed to by the licensor, the commencement date of the licence should be delayed until after the segmenting and indexing has been completed.

   For example, if the license duration is four years and provisioning of the digital video takes six months, the licence period should commence six months after the initial delivery of the source materials. This would allow use of the content for the full licensing period. However, it would not reasonable for the licensor to wait six months for payment. Payment would be upon signing the licence agreement, delivery of the source materials or in accordance with a payment schedule mutually agreed to with the licensor.

2. Multipurposing or Encoding Rights

   It is beneficial to obtain the rights to encode the digitized footage into various formats (QuickTime, Windows Media, MPEG etc.) and in varying bit rates. This should be done in-house (where the resources and expertise are available) to control video quality and cost: it is usually less expensive to encode in-house than it is to pay the provider each time the content is encoded in a different format or bit rate. Some content providers offer substantially discounted rates for subsequent encoding, however pricing policy varies among companies and should be negotiated with the content provider.

It is important to mention that not all content providers will allow in-house encoding of their titles as it erodes a source of revenue from their business model. Some providers are not prepared to relinquish quality control over the encoding of their product. For more details about content provisioning and multipurposing refer to the Multipurposing Specifications section of this report.

3. Distribution or Delivery Rights

The required delivery format of source materials (master tape or digital files) needs to be discussed with the licensor during the negotiation process. Alberta Learning commonly requests source materials in two separate formats: BetaCam and digital archival files (See Multipurposing Specifications below for more details). The cost of providing source materials in two formats may be included in the vendor's licensing fee or charged separately. Often these can be negotiated. Additional costs include shipping charges and/or digital file transfers.

4. Excerpting Rights

Many content providers are unable to grant permission for excerpting rights because content within the video has been licensed from third parties. Most often this content has been licensed from the rights holder for a *one time use only*. Excerpting segments or video clips from the original work is considered within the industry as re-purposing -- for the content to be used in this manner□a new license agreement detailing conditions of use must be negotiated between the content provide and the third party rights holder.

5. Downloading Rights

Distributing video over a network introduces a new and fundamentally different approach to the right-to-use intellectual property. The practice of *downloading content*, which has the potential to lead to un-authorized copying and transmission, is a major concern for content owners. On the other hand, many end-users are of the opinion that for optimal use, students and teachers need to have the right to download *to the desktop* (off-line from the network). Downloading and saving files locally does present some challenges for the end-user, including lengthy downloading times, storage issues, and assuming the responsibility to ensure licensing restrictions are adhered to and that content is removed once a license has expired.

Digital Rights Management (DRM) systems are defined as networked databases that combine data on content, content providers, users, licenses and usage, to either restrict or enable user access to resources delivered on a computer network (and more recently, to monitor and track all forms of usage). These systems provide a level of security over intellectual materials, however, because DRM standards and technologies are still evolving, many content providers remain hesitant to grant downloading rights.

### 5.2.4 Provisioning Business Models

Alberta Learning has adopted the licensing model (Figure 2) when acquiring third-party video for LearnAlberta.ca. Other provisioning models exist and are described below.

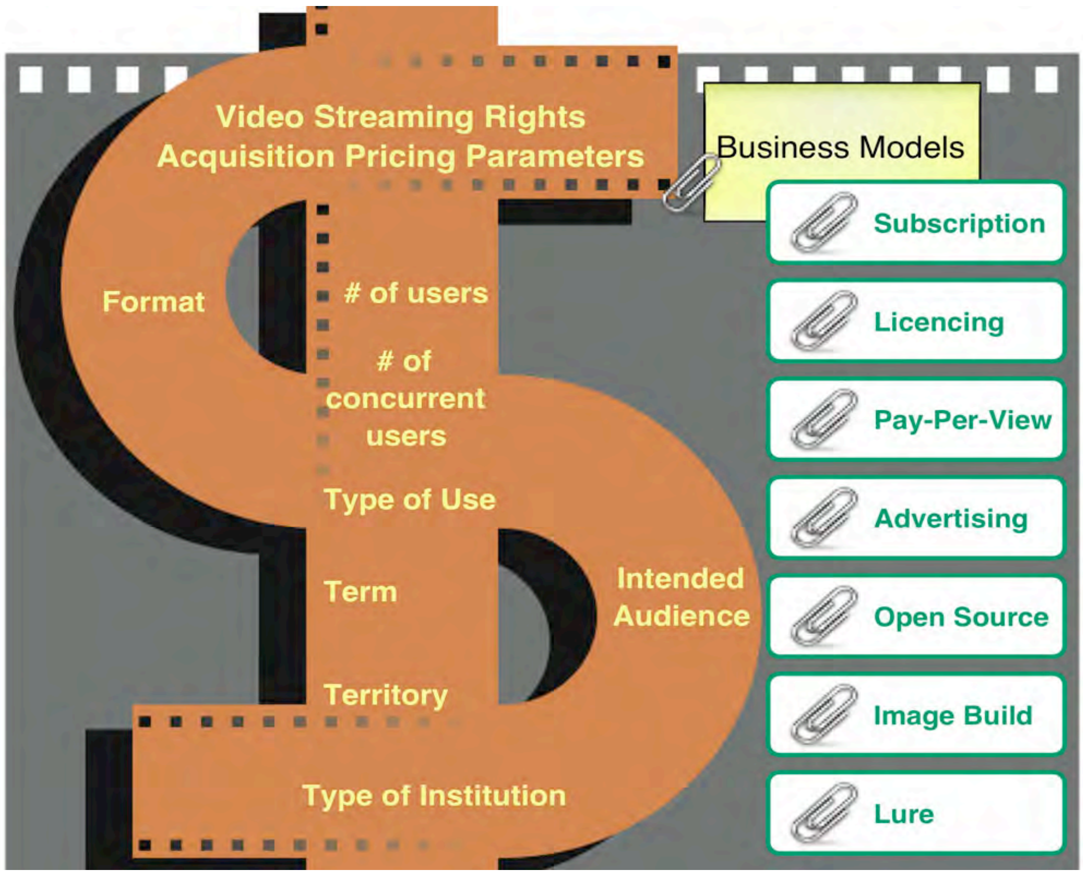


**Figure 2: Provisioning Business Model**

**Subscription.** One of the more common models, subscription is based upon users paying a set fee for access to content for a defined period of time (daily, monthly or annually). In some cases, service providers offer free content on their sites in addition to content that can only be accessed by a validated subscriber. Usage rates are not a factor in this model.

**Pay-per-View.** This "pay as you go" approach is based on metering the actual time the user spends accessing the service, usually calculated on set rate per minute, much like the traditional business model employed by utility companies. However, metering can also be based on the quantity of content accessed, i.e., number of images, articles, movies etc.

**Licensing.** Users pay a "one-time" fee for unlimited access to the content without time constraint.

**Advertising.** The service provider's revenue is derived from selling space on their web site to advertisers. The content on the web site (chat rooms, links to resources, forum, special features) is combined with messages from advertisers, often in the form of banners or feature articles. This particular type of service provider may also be a content provider or distributor of content created by others. Very similar in nature to a commercial broadcasting model, the advertising model will only work if the volume of user traffic is high enough to attract advertisers, or if the web site attracts a specialized target audience.

**Open Source.** No charge access based on a high commitment to contribute or share with the community. While open source is not likely a lucrative business model for a web site with highly produced video content, it has some merits, particularly when combined with other models. For example, MIT has combined an open source model (access to all content is free) that attract users to the site for content and then encourages them to enrol in courses and programs at the university for a fee and credit..

**Image Build.** Similar to the advertising model but without the overt advertising. Drug companies often create web sites that provide information to consumers and/or online learning for doctors and other professionals who use their products.

**Lure Model.** This model is commonly used by software companies. The service provider gives the user 80% of the content and the remaining 20% is accessed only by those that "pay-to-play".

Some video streaming services provide a short preview of a title to "lure" the user into purchasing the full-length feature. Employing the lure model, a service provider may also provide a basic service for free and offer integrated or enhanced features at additional costs.

### 5.2.5 LearnAlberta.ca Rights and Standards Overview

#### *5.2.5.1 Introduction*

The license agreements for some of the learning resources destined for LearnAlberta.ca required the technical management of digital rights. Much of the content, particularly video, was and will be available exclusively to Alberta students, parents and teachers. The ViStA Project did not undertake to test rights management solutions to these problems other than specifying use restrictions when uploading the IMS metadata records to the Campus Alberta Repository of Educational Objects (CAREO). This was done to ensure that these video would not be exposed to unauthorized users. The approach taken and considerations to restrict video use are described below.

#### *5.2.5.2 IMS Learning Resource Metadata Specification*

The Instructional Management Systems (IMS) Learning Resource Metadata Specification has a “rights” element group. This group contains three elements:

- Cost (value of either yes or no)
- Copyright and other restrictions (value of either yes or no)
- Description (textual description of the conditions of use)

Indexers at Alberta Learning included these elements in their IMS metadata records. These three elements only provided a minimal amount of information about the rights associated with each of the learning resources. The textual description of the rights, as implemented by Alberta Learning, was intended for display to the end-user and would contain information such as the video’s copyright information (e.g., © National Geographic Society).

It is also possible to add *additional* digital rights information in the IMS metadata records using the element group “Classification, Purpose – Security Level.” For example, if the digital learning resource was only licensed for use in Alberta, the Security Level keyword could be “AB”. If the learning resource was only licensed for a certain period of time, the expiry date could be included as another Security Level keyword (i.e., Expiry 2007-10-05). If the learning resource was licensed for use only by students, parents, and teachers, the Security Level keyword could be “Educational.” Such Security Level information could be included in the IMS record for each learning resource posted to LearnAlberta.ca. The intent of including this information would be to permit the conversion of the information to a more developed digital rights management solution at a later date.

#### *5.2.5.3 Review of DRM Standards*

In general, Digital Rights Management (DRM) refers to the management, tracking, communication and protection of the intellectual property of digital resources. For LearnAlberta.ca, a very specific and immediate DRM concern is to ensure that any use of its digital content complies with licensing agreements negotiated with content providers. As LearnAlberta.ca continues to grow and develop, unanticipated DRM issues may arise. Any DRM solution must be flexible enough to handle these unforeseen issues.

DRM is complex and, like other e-content support components, is undergoing development by various industries, sectors, and web standards organizations. Currently, many development activities for DRM standards are focusing on eXtensible Markup Language (XML)-derived languages designed to express DRM statements. Digital Rights Expression Language (DREL) solutions provide for flexibility and interoperability across systems that can translate the XML into specific instructions for the handling of digital assets. Note that the actual enforcement of the digital rights expressions is a separate function that is handled by the technical environment.

#### *5.2.5.4 Open Digital Rights Language (ODRL)*

ODRL provides a standard language for the expression of terms and conditions over assets. These include permissions, constraints, requirements, conditions, as well as offers and agreements with rights holders. ODRL aims to be compatible with a broad community base, to meet the needs of a variety of sectors, and be applicable to all media types. ODRL strongly supports open source development and has no licensing restrictions.

The development of ODRL has been influenced by many major DRM and metadata organizations including MPEG, IMS and Dublin Core Metadata Initiative (DCMI). It also seems to have the interest of some organizations in the mobile content and education/learning markets (i.e., ODRL has been adopted by the Open Mobile Alliance, formerly WAP Forum). Documentation from The Le@rning Federation, an Australian K-12 learning object repository project, indicates that they have implemented ODRL as part of their application profile that includes IMS Metadata. Furthermore, ODRL was used to enable digital rights management in the Collaborative Online Learning and Information Systems (COLIS) Demonstrator Project, whose participants include Australian universities and e-learning vendors. This project, along with the Le@rning Federation application profile, has significance for LearnAlberta.ca because they suggest that ODRL can be successfully implemented along with IEEE LOM, IMS Metadata and IMS Content Packaging.

An initial review of the documentation supports ODRL's claim that it is relatively easy to understand and implement. Furthermore, its apparent flexibility bodes well for addressing unanticipated DRM needs that LearnAlberta.ca might encounter in the future.

#### *5.2.5.5 XrML (Extensible rights Markup Language)*

XrML is a general-purpose language for expressing rights and conditions associated with digital content, services or any digital resource. Although the data model differs from ODRL, XrML expressions are designed with similar needs in mind: conveying rights to individuals or organizations to use resources under certain conditions.

ContentGuard, a company owned by Xerox (with Microsoft holding a minority position), governs XrML. ContentGuard has contributed XrML to numerous standards bodies in hopes that it will provide the basis for a single world-wide standard digital rights language. XrML has the support of some major organizations. For example, ContentGuard's XrML architecture has been selected as a basis for the development of MPEG-21 Rights Expression Language (REL). ContentGuard has very recently licensed its DRM intellectual property to Sony for the development, manufacturing and marketing of Sony products and services.

Like ODRL, XrML claims to be extensible, flexible, interoperable, and format-independent. XrML has been described as more complex and more mature than ODRL. A review of XrML documentation suggests that its complexity may make it be more difficult to implement than ODRL.

#### *5.2.5.6 Digital Rights Expression Language Study Group*

In 2002, the IEEE Learning Technology Standards Committee (LTSC) formed a Digital Rights Expression Language Study Group. This study group recently released a White Paper, entitled *Towards a Digital Rights Expression Language Standard for Learning Technology* (http://ltsc.ieee.org/meeting/200212/doc/). The goals of the study group included: investigating standards development efforts for DRELs and digital rights; identifying DREL requirements that are specific to education, learning and training; feeding these specific requirements into ongoing DREL and digital rights standardization efforts; and making recommendations about how to proceed. While the paper represents progress towards these goals, it is hoped that the recommendations for further work will be acted upon. A great deal depends upon the future direction that is set for this study group.

#### *5.2.5.7 Recommendations*

The issue of DRM is complex and needs further research before any final decisions are made. It is recommended that DRM developments, including the adoption of ODRL and XrML by organizations, be closely monitored. Any further work from the IEEE LTSC Digital Rights Expression Language Study Group must also be examined. In addition, the November 2002 IMS Member Dispatch mentions that the IMS Digital Repositories Interoperability Team may form a special interest group in "Information Management" within which digital rights management would be considered. Alberta Learning staff working in this area believe it is important to monitor developments in all of these areas and, in the meantime, agree that the investment required to include Security Level metadata in the IMS records at this point in LearnAlberta.ca's current metadata implementation is not justified until activity in the DRM arena stabilizes

## 5.3 MULTIPURPOSING

### 5.3.1 Definition

Multipurposing includes the capture and preparation of digital video files, potential delivery systems, transport mechanisms, and digital rights management. It also includes the specifications for multimedia client players and plug-ins; media file types, Internet browsers, and minimum client hardware requirements for optimal video performance.

### 5.3.2 Background

Many types of video files and standards exist at the present time. Many source file formats as well as many potential streaming formats also exist. It was therefore necessary to establish standards that would meet the streaming requirements of the project.

One goal of this portion of the project was to establish one specific video bit rate that would create a video or video stream with acceptable visual quality and performance across both the SuperNet and consumer broadband environments (i.e., Telus Velocity or Shaw High Speed Internet) within Alberta. The movie had to maintain that visual quality and performance at both its normal size and full screen size on a computer monitor or data projector.

### 5.3.3 Video Streaming Industry Trends

#### *5.3.3.1 The ViStA Perspective*

When researching video architectures and formats, the ViStA team needed to evaluate current market trends and, more importantly, determine which technologies are the best fit for LearnAlberta.ca. Schools in Alberta are largely autonomous in technology standards. Some school districts maintain system wide standards for hardware, software, and networks while others permit each school to make site based decisions. Over the years schools have implemented multiple platforms, software and architecture. This has resulted in a very diverse install base of hardware and software. The primary goal in researching streaming video was to determine which present technologies could reliably serve as many of these technically diverse users as possible while providing a pathway for future interoperability. Maintaining backward compatibility with the install base coupled with support for open international standards was part of this goal as well.

Delivery of video to an end user requires the examination of all of the components from source server through to the end user. The following information describes the requirements for each component of the video streaming technical environment "end-to-end".

#### *5.3.3.2 The Client Player*

Software is required to view a video on a computer. The client player software needs to have the same features and functions across all supported platforms and operating systems. It must be freely available and easy to install with exceptional support. There has to be a clear vision on where the technology is headed in terms of formats and support for open international standards. The player interface should possess a high level of functionality and elegance in its design and not perform hidden processes centered on marketing and covert information gathering.

#### *5.3.3.3 The CODEC*

Video files contain a great deal of data and can be quite large. It is often necessary to compress the video files to reduce file sizes or, in the case of streaming video, to reduce the amount of bandwidth necessary to deliver the video. The method used to COmpress/DECompress video is referred to as a CODEC. This determines the frame rate, size, sound quality, and so on. The CODEC selected needs to produce very high quality streaming video at relatively low bit rates on moderately powered desktop machines. There must also be good availability of exceptional tools for encoding video using this CODEC. The CODEC must be native to the client player and not an extra cost or download.

#### *5.3.3.4 The Streaming Server*

Once video is digitized and compressed for streaming, it must be copied to a server capable of delivering multiple video streams. The streaming server needs to be efficient, flexible, scalable, and cost effective. It needs to support international standards for streaming transport protocols and formats.

#### *5.3.3.5 Trends*

Market forces have resulted in significant changes in streaming video in the past year. From a user perspective, the streaming of "on demand video" can no longer be confined to a small blurry frame on a desktop computer. Broadband, high performance formats and generally better technologies promise high quality digital streamed video on consumer electronics ranging from cell phones to televisions.

The problem that industry faces is selecting the correct CODECs to use with various video architectures. It would be desirable to encode just once for all platforms and devices. It would be desirable to standardize on a non-proprietary ISO standard video format that had the potential of meeting the emerging technologies for viewing video beyond only the desktop. Support for standards would alleviate existing user problems such as having the right multimedia player installed. If the player is compliant to the standards, then any approved content could be viewed by the user

MPEG-4 is a standard that appears to be where industry is headed. The next iteration of MPEG-4 will use the Advanced Video CODEC (AVC), also known as H.264. AVC will most likely be the next format for DVDs. Some testing of this format for HDTV has also occurred. These are just a few examples of where a single standard format could serve many uses.

#### *5.3.3.6 Conclusion*

Recommendations for the client player, CODEC, and streaming server were based on the expressed needs of the various stakeholders and align with current industry trends in the area of video streaming. For detailed recommendations please refer to Appendix: Video Streaming Technical Implementation Guide.

### 5.3.4 Best Practices

#### *5.3.4.1 General Comments for Preparing Digital Delivery:*

The following methods to prepare video for digital delivery are recommended:

- De-interlace video.
- Adjust for best overall appearance (contrast, brightness, color balance).
    - Raise gamma 15 units when working from a Macintosh platform.
- Prepare for streaming for those cases where licensing rights have not been obtained if the segment is over 5 minutes long or exceeds 20 MB of hard drive storage.

#### *5.3.4.2 Reasons for Selecting QuickTime as a Digital Video Format*

When comparing digital video formats, notably QuickTime and Windows Media, it became apparent that formats are relatively equal in quality and performance for any given bit rate. The qualities of the player/plug-in would prove to be the best indicator of which format would best meet LearnAlberta.ca and its stakeholders' requirements. The diverse install base of computers in Alberta schools includes a large number of Macintosh computers.

The support for international standards is essential in many aspects of the LearnAlberta.ca architecture. Open standards help promote interoperability, scalability, and future proofing. Adherence to international standards is also important because the content being produced could be accessed from a wide variety of platforms and operating systems around the world. QuickTime supports ISO standards for delivery protocols as well as digital video formats and has shown a strong commitment to the open standard model.

Many Alberta school districts standardize computer images for student and staff use. These standards are implemented and remain unaltered for various lengths of times. A process was established to standardize the software required to play video content. This involved selecting the players and plug-ins, posting the recommendations for discussion, and establishing them for the next school year.

In order to keep the required player/plug-in set to a minimum it is desirable to focus on those that can perform a variety of tasks. Aside from playing audio and video, QuickTime can also play several forms of media in tracks (Flash swf, text, 3d, virtual reality, graphics, etc.) with the ability to incorporate *interactivity* within the movie file. Based on the experience of the ViStA project group, QuickTime was selected for the multimedia development platform and client player.

Version compatibility is extremely important when the client platform and operating system implementation is as diverse as it is in the LearnAlberta.ca environment. Releases of player/plug-in versions must be identical in function and in features to provide consistent dependable and predictable playback behavior. QuickTime releases were consistent with this requirement.

Backward compatibility is essential to insure that legacy material will always remain technically valid and usable. QuickTime continues to support all of its previous video CODECs and media types.

Based on their experiences, the team established the following specifications for the encoding of digital video for either streaming or downloading at various bandwidths. It is also recommended that these details be reviewed on a regular basis. With the release of this documentation, the timing of the release of the MPEG-4 standard, available software, and the need to communicate technical requirements to school jurisdictions with several months notice, Alberta Learning is currently not implementing the MPEG-4 standards. This decision also needs to be reviewed at regular intervals.

#### *5.3.4.3 Looking Forward*

Implementing QuickTime enables the strategic move toward International Standards Organization (ISO) compliant content since QuickTime currently supports these standards natively. This maximizes both backward compatibility and "future proofing" by being able to deliver ISO compliant content such as MPEG-4.

## 5.4 INDEXING

### 5.4.1 Definition

Indexing is the classification of information in an orderly manner and thus provides a reference for future searching and retrieval of items. In the specific case of this project, indexing was performed using the IMS Learning Resource Metadata Specifications and Synchronized Multimedia Integration Language (SMIL). Efforts to integrate indexing with the media preparation processes on the ViStA project helps optimize an efficient and logical work flow. For the purposes of this report, indexing is reported separately to provide clarity.

### 5.4.2 Background

The purpose of this research was to test Alberta Learning's planned implementation of search and discovery metadata for their digital video learning resources. Metadata records were created for three National Geographic Society video titles: "Dinosaurs on Earth…Then and Now", "Ecosystems-Struggle for Survival", and "Creepy, Crawly Creatures in Your Backyard." Metadata records were created for each entire video, as well as for shorter segments of each video.

Metadata elements, listed by element group, included:

<u>General elements</u> - Title, catalog, catalog entry, language, description
<u>Lifecycle elements</u> - Version, status, contribute role, centity, date
<u>Metadata elements</u> - Catalog, catalog entry, contributing role, centity, date, metadata scheme, language
<u>Technical elements</u> - Video format, size, location, other platform requirements, duration
<u>Educational elements</u> - Intended end user role, context, typical age range, language

Digital rights elements - Cost, copyright and other restrictions, description
Relational elements - Kind, resource description, catalog, catalog entry
Classification elements - purpose, taxon path, keywords

Once these elements/categories were determined, the indexing team investigated possibilities for presenting the streamed video and video segments. They decided on SMIL, a markup language similar to HTML that can be deployed on web sites. SMIL was created to solve the problems of coordinating the display of multimedia on web sites and is typically used for "rich media"/multimedia presentations which integrate streaming audio and video with images, text or any other media type. A simple implementation of SMIL was tested and found to be an effective solution for having the video stream start and end at the times specified in the SMIL record. For the ViStA tests, the link between the IMS metadata record elements and the SMIL record was made by using the technical location of the SMIL record as the value for the technical location in the IMS metadata record.

The digital librarians (indexers) chose XMLSpy to create the index records. The ease with which it copied records, particularly for video segments where much of the information was the same for each segment, made this software a fast and efficient tool for the creation of metadata records. However, XMLSpy did not allow for efficient addition of the learning outcomes text. The Learning Outcomes Vocabulary Browser built by the University of Calgary and integrated with ALOHA, allowed indexers to search or navigate to the appropriate specific learning outcome and have the entire taxonomic path for the learning outcome populated in the classification element with the click of a button.

A fully functioning version of the Alberta Learning Object Hub Application (ALOHA) (see Figure 4.0), with the Learning Outcomes Vocabulary Browser (see Figure 5.0) became available in September 2002. ALOHA is a framework designed to ease educational markup and publishing of media objects in a standards-based fashion. Indexers found the ease with which they were able to incorporate the learning outcomes to be one of ALOHA's best features. The search capability of the browser was also easy to use, although navigation was at times an issue due to the length of the text of the learning outcome. Other useful features of ALOHA were the ease of uploading metadata to the CAREO repository, the ability to view the XML source data, the ability to select or overwrite vocabulary items from menu-driven lists, and the save-as, save-as-template and print functionalities.

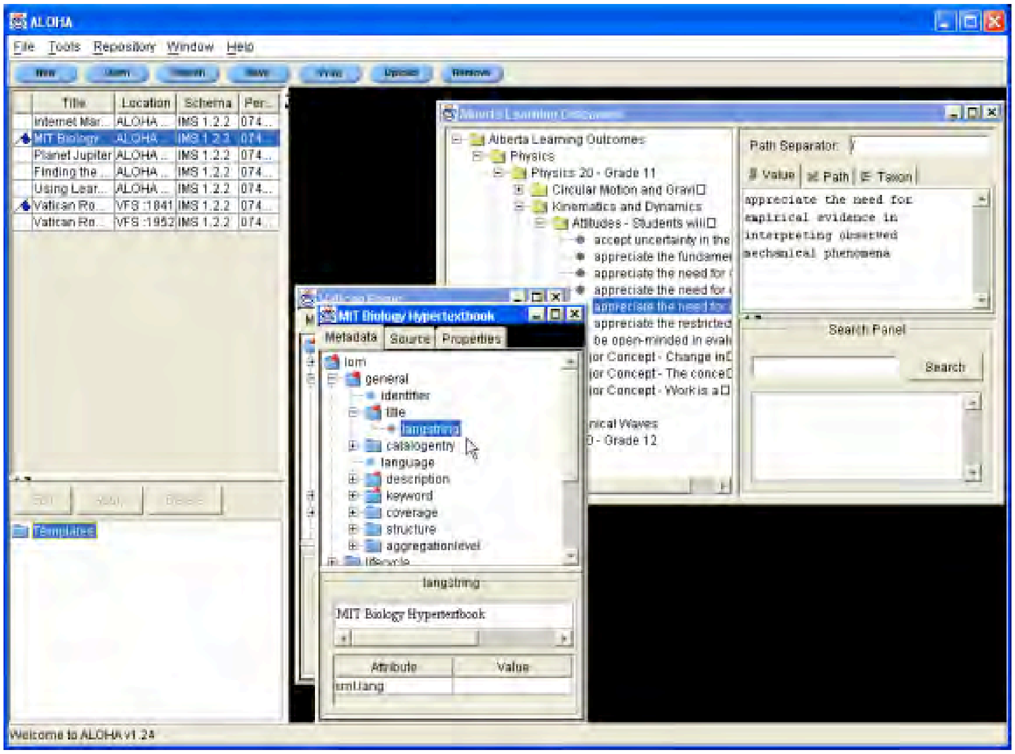


Figure 3: ALOHA Tool with Alberta Learning Outcomes Browser 2002

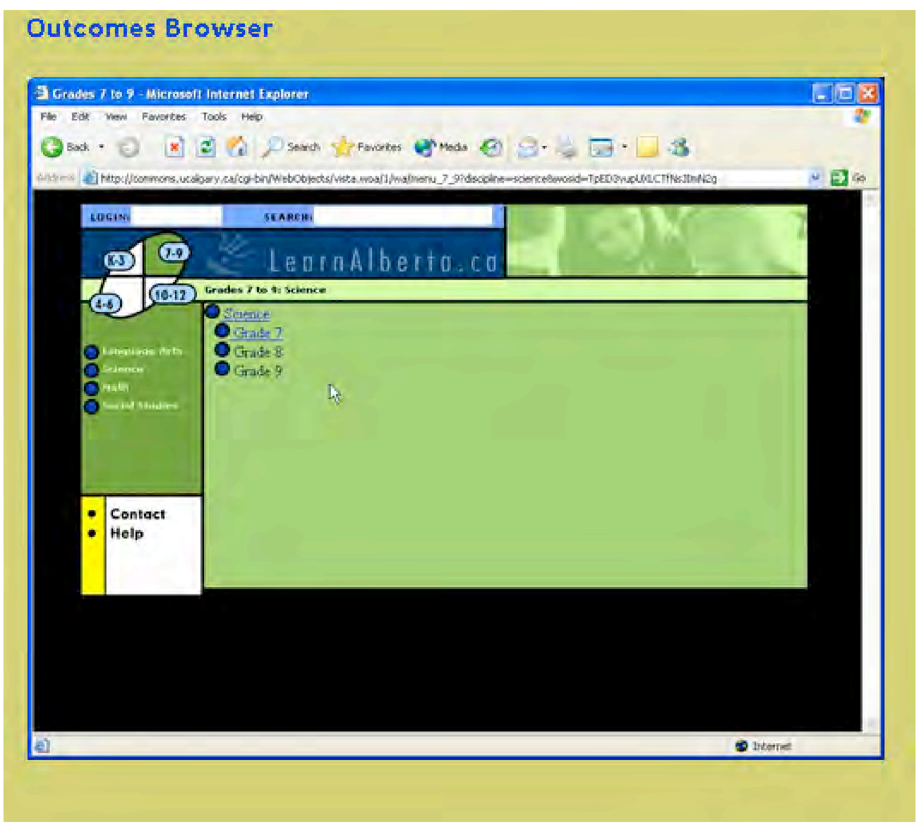


Figure 4: Prototype of web-based interface for browsing Alberta Learning Outcomes

Indexers also identified a number of features that would enhance ALOHA, as well as some existing features that needed modification. Indexers would have preferred to have the ability to edit records in the XML view, the use of a spell checker, and the ability to create user-defined defaults, such as selecting which IMS elements would be included/not included. One problem that was encountered at the time of testing was that ALOHA was unable to consistently maintain the order of any repeated elements in a metadata record.

Indexers found the tree structure of the ALOHA tool to be easily understandable and workable. However, in their feedback to ALOHA developers, indexers recognized that non-professional indexers might have difficulty understanding the tree structure and the semantics of the IMS element names. A more explicit forms-based interface was suggested as a possible solution.

### 5.4.3 Best Practices

Valuable information about tools, learning outcome taxonomies, age-appropriate language, indexing processes and IMS data elements was gained through the indexing of the video for this project. Further evaluation of metadata/indexing in the following areas would also be valuable for informing and validating the planned metadata implementation.

#### *5.4.3.1 Taxonomy of Learning Outcomes in the Classification Element Group*

In the ViStA tests, users were only exposed to a browse of the Unit/Topic/Strand level of the learning outcome taxonomy. Evaluation of both search and browse capability of deeper levels of the learning outcome taxonomy (i.e., general learning outcome, specific learning outcome) would assist indexers in their decision-making.

#### *5.4.3.2 Searching*

The ViStA tests did not involve users conducting either partially guided searches or free searches. Indexers would like feedback on terms used in some of the vocabulary elements (i.e., the use of Library of Congress subject headings), keyword searches on elements such as description and contributor, and advanced searching combining elements such as typical age range (with a mapping to grade) and format (i.e., video) and a keyword from the description.

#### *5.4.3.3 Relation*

Alberta Learning's planned use of the element group *Relation* was not tested. Users were not exposed to the metadata, which lists the relationship of the video to other video resources. Indexers would like to determine if users find it useful to see all of the titles of the video segments of a particular video or conversely, the title of the complete video which a video segment belongs to.

#### *5.4.3.4 User Appropriate Language*

Technical environment options should be explored and evaluated to address the issues previously identified in this report about age/user appropriate language in the metadata records.

#### *5.4.3.5 Search Results/Display*

There are several unanswered questions about search results which should be further investigated. After a search is conducted, what metadata elements should be displayed, at what point and in what format, to the end user?

#### *5.4.3.6 The Future of Indexing*

At this time, indexers at Alberta Learning are continuing to use XMLSpy as their primary indexing tool. In terms of time, indexers found XMLSpy to be the most efficient. XMLSpy does not allow for easy, error-free entry of the Classification Learning Objective so there is a need for an additional tool for this. If ALOHA is going to be used as the indexing tool for adding Learning Objectives to the metadata records, further work is required to incorporate the remainder of the outcomes into the Learning Outcomes Vocabulary Browser. At this time, only eight Programs of Study have been incorporated into the Browser.

## 5.5 INSTALLATION

### 5.5.1 Definition

Installation is defined as the process of uploading digital video files and their corresponding metadata onto appropriate servers. For the ViStA project, many digital videos were also accompanied by SMIL records. SMIL records are small files that point to locations within a video and thus create a virtual segment. A web server was required to store SMIL records. Specialized servers for metadata and streaming video were also required.

### 5.5.2 Background

Standard installation techniques rely on FTP clients, accessing appropriate servers and locating files in correct locations. A pre-existing infrastructure provided by the Campus Alberta Repository of Educational Objects (CAREO) and Advanced Learning Object Hub Application (ALOHA) facilitated the installation of metadata and digital video. The digital video was transferred onto streaming video servers and the XML metadata records were transferred to the CAREO metadata repository.

ALOHA was also used for indexing digital video, providing a workflow from metadata creation to the installation of that metadata and the streaming video file.

### 5.5.3 ALOHA Features

The primary function of ALOHA was to index learning objects. It offered advantages over other indexing solutions such as:

- a flexible user-friendly interface for amateur users.
- allowed an interface that was customizable for professional indexers.
- allowed easy creation, sharing and customization of index templates and forms.
- allowed automatic parsing input of metadata for over 200 file types.
- allowed easy marking of IMS or other forms of metadata.
- provided a number of administration tools for managing workflow issues with multiple indexers.
- supported any valid XML schema (such as IMS).
- provided simultaneous uploading of learning objects and metadata to an appropriate media server, thus negating the need for a separate FTP program.

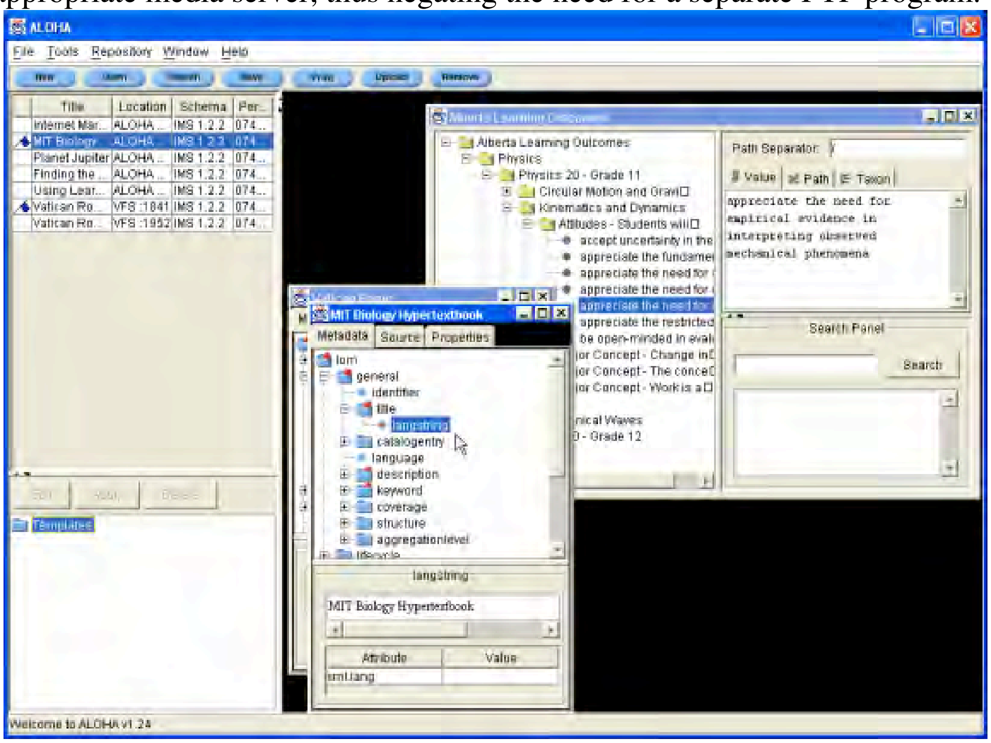


**Figure 5: ALOHA Interface**

The central repository, CAREO, was based on a distributed architecture. This means that several different metadata repositories could be linked together to allow federated searches for content located on several different servers. This permits users to develop specialized metadata for local needs while still allowing specialized servers to be deployed to deal with specific issues related to the media they contained (Figure 6).

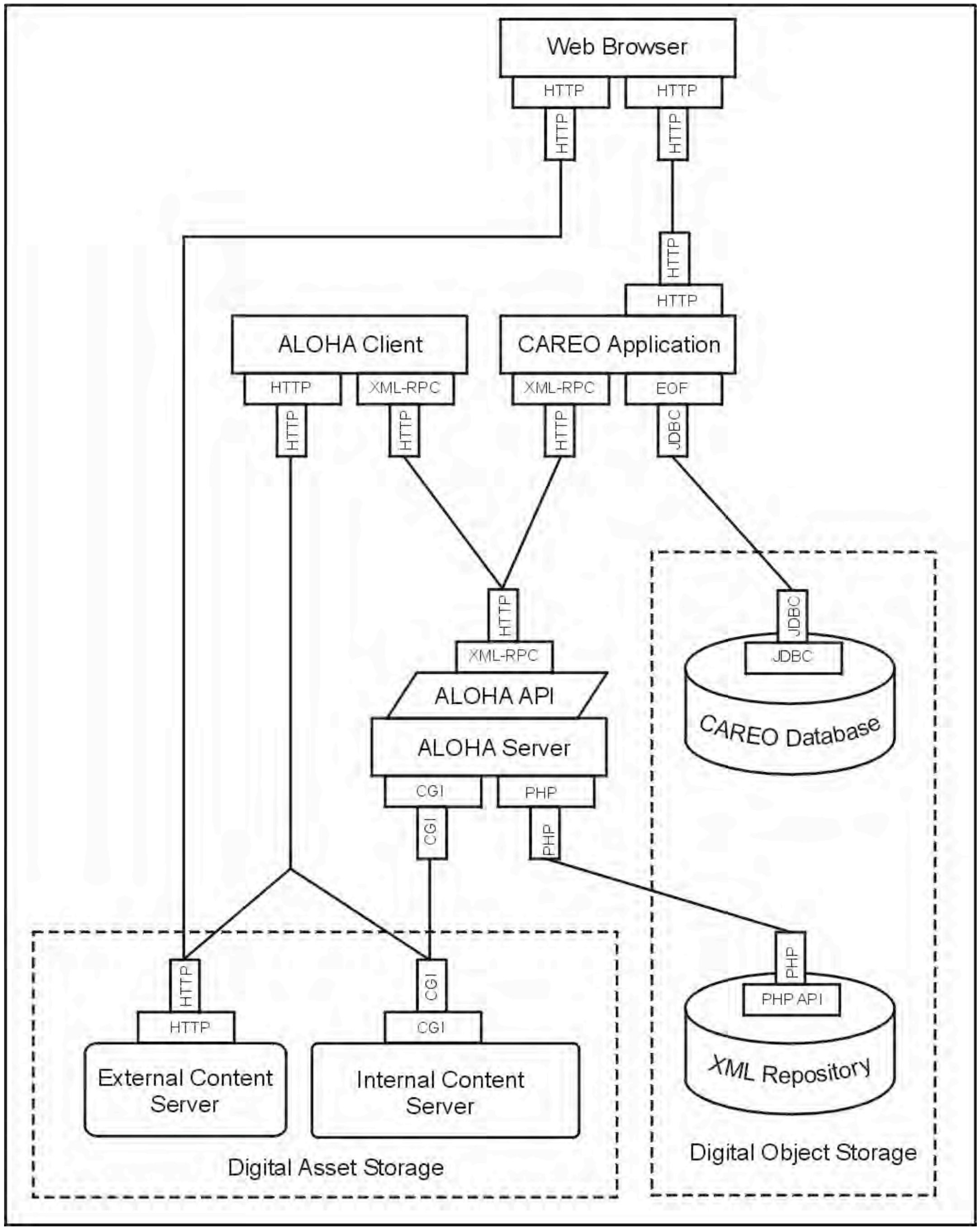


**Figure 6: ALOHA/CAREO Architecture**

### 5.5.4 Usability Testing of ALOHA

On August 23, 2002 the current and new versions of ALOHA were evaluated for usability with a small focus group of indexers from Alberta Learning. The summary comments appear below.

### 5.5.5 Summary of ALOHA Focus Group Comments

*General Comments*

- It is much better than it used to be.
- Having both windows open at the same time is good.
- Being able to see the source is very useful.
- Being able to print our records is also useful.

*Further Functionality*

- Templates are a good idea, but not implemented in a way that is useful, perhaps a save as feature would work as well for files with common metadata.
- Ability to merge files would be useful.
- The ability to edit source would be very useful.
- Frustrated with pulling down items to enter information.
- A mechanism to focus on what was just added would be useful.
- Form-based interface would help unfamiliar users.
- Adding Learning Object Browser permanently would be useful.
- Ability to add and customize attributes.
- Minimum and maximum values included but tool could include a default value.
- Dublin core.

*Is the metadata process organized in a logical way?*

- Some may need to check with the Guide frequently, but others that know IMS Metadata well should have no problems.
- Going to the online IMS Guide seems to work.

*Language*

- ALOHA language - form based input may be unfamiliar to some.
- Metadata is difficult to understand.
- Being able to fill in vocabulary is good.

*Do you think teachers will use this? How much education is required?*

- The tool would have to be easier, a forms-based interface would help a lot. The potential for making errors is high, this would have to be minimized.
- Learning object browser would be a great thing.

## 5.6 ACCESSIBILITY

### 5.6.1 Definition

Accessibility refers to the user environment (i.e., user interfaces, search engines, browse functionality and information design). To facilitate access to video resources by students, teachers and parents, dynamic and static user interfaces were also evaluated by placing them on existing CAREO applications.

### 5.6.2 Background

The Campus Alberta Repository of Educational Objects (CAREO) is an online repository of educational objects, originally intended for post-secondary educators in the province of Alberta.

The infrastructure of the repository has several different elements including Alexandria, a national repository project and the Vancouver Film School Repository, a repository dedicated to film and multimedia projects. This infrastructure has attracted a community of users that both create and support the objects in the repository. Over 3100 educational objects were added in the first year.

CAREO has created several tools that have encouraged the use of the repository. The objects within this repository were designed to be freely available to educators both in and beyond Alberta.

The CAREO repository is currently focused on being a digital content management system. It does not have capability for a course or learning management system. It does have login capabilities that allow for the tracking of users. These login attributes allow for the user to be authenticated and enter into different systems to take advantage of more complex functions.

### 5.6.3 Best Practices

Many of the current interfaces were designed and created from existing feedback from K-12 students and teachers. However, further modifications were required based on recommendations from the instructional design and metadata group at Alberta Learning. An effective interface should consist of:

- Improved browsing ability for the Learning Outcomes Browser, including a more user-friendly approach to browsing the complex hierarchy that has been designed by Alberta Learning.
- More comprehensive searching abilities including both partially guided and free searches.
- Clearly defined relationships between objects should be presented to users. The existing system did not provide links between objects or define the organization of complex objects.

It was also noted that the language presented to the student users in the browse structure was often aimed at higher reading levels. It will be necessary to offer the ability to explore the educational material at a communication level appropriate to the audience.

An interface design that was focused on a K-12 audience would be required. ALOHA would have to adopt other features in order for the content to be placed in a relevant context for K-12 students. The needs of the various users would have to be defined so that the CAREO software could be modified and new interfaces could be designed for the system.

The initial work in this area resulted in the creation of the content interface design guidelines from the ViStA Interface Design Workshop. This document served as the starting point for the development of the initial prototype.

The main focus was the search and retrieval functionality required from the system and how this would relate to K-12 curriculum content. The guidelines did not deal with digital rights management, metadata creation workflow or age specific interface issues. These were dealt with later during the prototyping exercises.

***5.6.3.1 Opening/ Splash Screen requirements***

It was agreed that a splash screen for the user would be required. The focus of the splash screen would be to inform and direct the user towards content that was appropriate and relevant. Several essential features were outlined for this screen. It was to:

- Identify the user (i.e., category of user: teacher, student, parent, administrator or guest).
- Give the user the ability to select a customized browser that matched their user category.
- Provide information to the visitor on:
    - The purpose of the site and the principles behind it.
    - Highlights of the various resources and how to use them.
    - Details on how the site could be used.

The team expanded these features to add a number of other user-friendly enhancements:

- Information and Requirements
    - Plug-ins that are required and links to get them.
    - A browser 'tune up.'
    - Troubleshooting help.
    - Testing tools (including a test clip to test the user's system).
    - FAQ section.
    - User tour for all visitors so that they would be able to be shown through the site. This tool was considered both informational as well as a potential showcase of the content.

- Policies
    - Copyright information.
    - Disclaimer.
    - Statement of privacy, i.e., Freedom of Information and Protection of Privacy (FOIPP).

- Project Information
    - The status of the site.
    - Recent updates.
    - Acknowledgements.

- News.

It was decided that each of these elements need not be immediately viewable by all of the user groups, however a placeholder for each element should be contained within all of the interfaces. Some elements would need be placed discreetly in some user interfaces compared to others (i.e., for students, copyright and disclaimer information would not have to 'pop up' immediately but should still be available).

#### *5.6.3.2 Browsing*

The implementation team agreed that after a user has selected the browser most suitable for their user category, they should be able to browse in two ways:

1. Focused browsing, through the use of search engines.
2. General "scanning the bookshelves" browsing.

They also felt that users should be able to see more than they requested. In other words, recommended objects, most frequently used objects and objects with a similar search parameter should be presented to the user so they could choose from a wider variety of objects.

When determining the searching/browsing specifications, the following conclusions were reached:

- Students should be able to browse by Subject.
- Teachers should be able to browse by Subject, Learning Outcome, Grade, or Course.
- The interface view should be appropriate to the user group and be customizable (in a limited fashion) by the user.
- The site must be designed to be "flattened" as much as possible, meaning:
    - The user should be able to bookmark frequently used objects.
    - Shortcuts should be provided to objects most frequently used by ALL users.
    - Smart browsing (along the lines of Amazon book recommendations) as the viewer browses, objects along a 'similar' description (course, grade, learning outcome, subject) should be offered to the user for consideration.

#### *5.6.3.3 Navigation Bar*

The location of the navigation bar and its basic layout should remain constant throughout each user category, as well as throughout the site. Users should also be able to perform some limited customization of the navigation bar itself (i.e., choose the order of buttons, delete or add buttons as required).

Whenever objects are displayed, they should also include a key-frame if possible. The site should be as "visually alive" as possible, and results of browsing opportunities based solely on text should be avoided if at all possible. Icons and images from the actual objects (the key-frame references) should be used to assist the user in finding the material or category of material they are searching for and icons should also be used to indicate the format of the object available (i.e., video clip, text file, picture file).

#### *5.6.3.4 Search Features*

The implementation team recommends the search features be organized in the following way:

Simple Searches

A simple search should be available on each page and from the same location on each page. It should include the ability to search by title, description or topic and should not be hierarchical.

Detailed Searches

A link for a detailed search should be available on each page and from the same location on each page. It should include the ability to search by:

- Title
- Description
- Grade or division level
- Subject area
- Media type
- Media format
- Educational object type
- Date produced
- Who contributed it (source)
- Intended user role (for teachers only)
- Language
- Accessibility
- Specific learning outcomes
- General learning outcomes
- Whether or not the content is downloadable

Each of these detailed searches should include:

- Drop down menus as the default data selection method.
- The inclusion of certain metadata (i.e., learning outcomes)
- The potential for users to customize a typical compact and expanded search and the search results for their own needs. This could include:
    - The ability for users to change the number of results (period, per/screen) and others preferences.
    - The option to view results in either a compact or expanded format.

#### *5.6.3.5 Search Results*

Search results should be influenced by the role-based authentication and user type selected. They can be displayed in either compact or expanded formats.

Search results in compact format should include:
- Title
- Course/grade
- URL/location of the object
- A short description of the object
- Media format
- Educational type
- Language
- Search criteria used

Search results in the expanded format should include:
- Title
- Course/grade
- URL/location of the object
- A full description of the object
- Media format
- Educational type
- Language
- Search criteria used
- Duration
- Date produced
- Thumbnail
- Outcomes (teacher only)
- All other detailed search criteria

#### *5.6.3.6 Common Threads to the Discussions of Best Practices*

The team recommends the following for future projects:

- Interface objects should be consistently placed on all pages.
- Customization should be a primary focus (the user has to be able to make the interface their own).
- Through user preferences, users should be able to set all search options to their particular search preferences.
- The language of the interface must be in the language of the user. This includes the searching mechanism and results. Users should have the option of utilizing either Boolean logic or natural language.
- For spelling concerns, the results page should take 'best guess' and respond with a "Could this be what you meant?" rather than a zero results.
    - Zero results in a search should be avoided.

    - Search results should provide optional objects on similar topics to be displayed (i.e., Amazon's if you like this book, you may want to try…).
- Icons should be developed to represent file formats. These icons should be designed to the user profile.
- Teacher tools should be integrated so that teachers can aggregate their object discoveries.
- All features should be available to all users, though some should be more discreetly revealed based on the type of user.
- Serious consideration is required for the Help functions of the site. They must consist of more than just definitions of terms. They must instead help and guide users through the interface, as well as be able to answer 'why' certain things are occurring.
- Tours should be part of the site to introduce new features and to assist in orienting new users to the site.

### 5.6.4 Evaluation of Interfaces

The Evaluation Group of Academic Technologies for Learning (ATL) at the University of Alberta conducted evaluation activities related to the accessibility component of the project.

The evaluation focused on usability testing to determine best practices related to the pedagogical and technical requirements for streaming video in Alberta. Evaluation activities were carried out in co-operation with the stakeholders from March to December 2002.

Three videos were chosen for the usability tests. For the static interface testing, the video "Creepy, Crawly Creatures in Your Backyard" was selected. For the dynamic interface (Figure 7) testing, two videos were chosen: The first video, entitled "Ecosystems" was an older video of poor quality. The segment prepared by the indexers, "The Spotted Deer" was approximately 2 minutes in length.

The second video used in the dynamic tests conducted in Calgary was entitled "Dinosaurs". The first section shown to the students was in cartoon format. Animation compresses differently than true life. It was not as valuable to the usability testing as the 2-minute segment on T-Rex. The "T-Rex" segment was better able to demonstrate the true capabilities of video streaming on the network.

Seventy-one school children were tested in front of computer screens, one-on-one with an evaluator. Testing was done in two phases: the first to elicit feedback on the static interface for the purpose of informing the building of the dynamic interface, and the second phase to elicit feedback on the usability and functionality of a partially functional dynamic interface, and the accompanying pedagogical implications. Pre-determined sets of questions, varying by age group (Kindergarten - Grade 3, Grade 4 - 6, Grade 7 - 9), were asked to students in both rural and urban schools across Alberta (Edmonton, Grande Prairie, Innisfail, and Calgary). The evaluator recorded the responses.

Eight junior high teachers from participating schools (Grande Prairie, Innisfail, and Calgary) also took part in the usability testing.

Fifty-five parents completed a demographic survey administered in order to help determine the backgrounds of the participants especially in terms of technology use in the home environment.

Seven members of the ViStA steering committee also completed an online survey designed to pilot the static interface before it was tested with the students. The online survey provided formative feedback to the developers and designers.

Structured interviews and focus groups were used in the evaluation of the content provisioning and multipurposing, installation, and the content accessibility components of the ViStA Project. The purpose of this approach was to gather more in-depth qualitative information to guide improvements to the ALOHA tool and to provide direction for the CAREO implementation. The primary participants were developers and indexers who have worked with CAREO and ALOHA.

The data analysis process for this project was comprehensive. Several phases and levels of data organization and analysis were conducted in order to ascertain the "essence" of the messages being expressed by the participants.

The primary technique utilized for this project was inductive content analysis.

### 5.6.5 Parent Demographic Summary

#### *5.6.5.1 Background*

The parent survey was designed to explore demographics and children's use of technology in the home. Television viewing and computer use were of particular interest to the ViStA Project as they provide a snapshot of the experience and expectations of children as video streaming is introduced.

In total, parents of children ranging from Kindergarten to Grade 10 completed 55 parent surveys. (See Survey Questions in Appendices: Interface Evaluation Final Report) Parents from Edmonton, Grande Prairie, Innisfail, and Calgary responded to the demographic survey.

- Parents who have children in kindergarten – Grade 3 completed 7 of the surveys.
- Parents who have children in Grades 4 - 6 completed 7 of the surveys.
- Parents who have children in Grades 7 - 10 completed 41 of the surveys.

#### *5.6.5.2 Summary*

Most children in the Kindergarten to Grade 3 age group spend time watching television and playing computer games. Because children are still learning to read and write, online chatting and assisted instruction are the least popular activities on the computer.

Compared to the other age groups surveyed, children in the Grade 4 - 6 age group spend the most time playing video games delivered via a gaming console (i.e., Playstation, X-Box, GameCube). Surfing the Internet was a very popular activity with this age group. Word processing and assisted instruction seemed to be the least popular activities.

Most children in the Grade 7 - 9 age group are using the computer for a wide variety of activities, which included chatting online, word processing, and searching the Internet.

There appears to be a positive correlation between age and the amount of television children are watching. As the children get older they are spending more time watching television.

It also appears that older children are more likely to have access to high speed Internet.

The older the children become, the more time they spend on their home computer. Time recorded on the computer begins with an average of 1 hour a week in Kindergarten to 10 hours a week in Grade 10.

### 5.6.6 Static (non-interactive) Interface Data Student Summary


**Figure 7: Opening Splash Screen**

The Opening Splash Screen (Figure 7) was designed to provide a portal into the general areas associated with the four grade groupings.

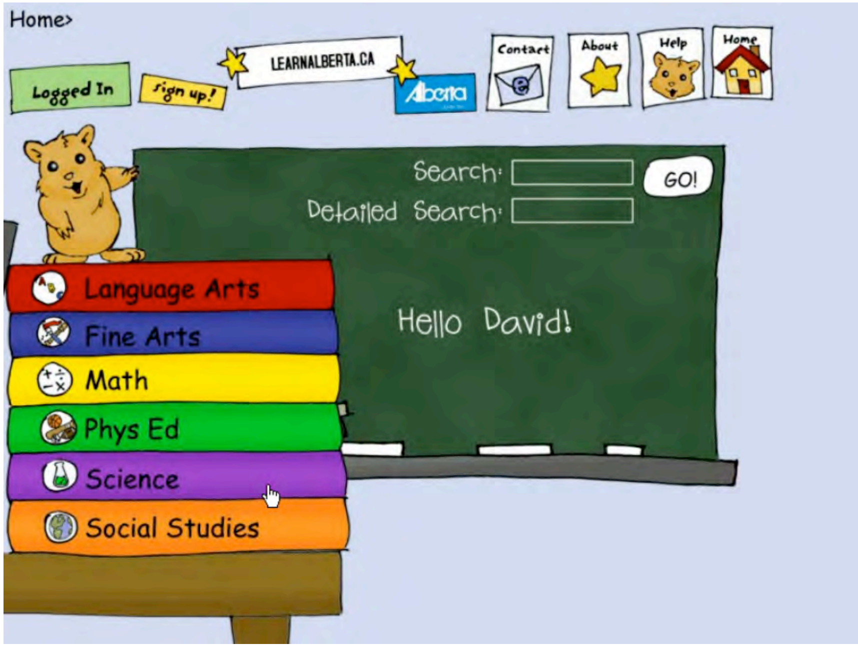


**Figure 8: K - 6 Opening Screen**

A cartoon character navigator/avatar was presented to provide navigation assistance to students (Figure 8). The feature was accessed through the help button or the avatar itself. Other screens demonstrate Navigator/Help (Figure 9), Subject Browser (Figure 10), and viewing screen (Figure 11).

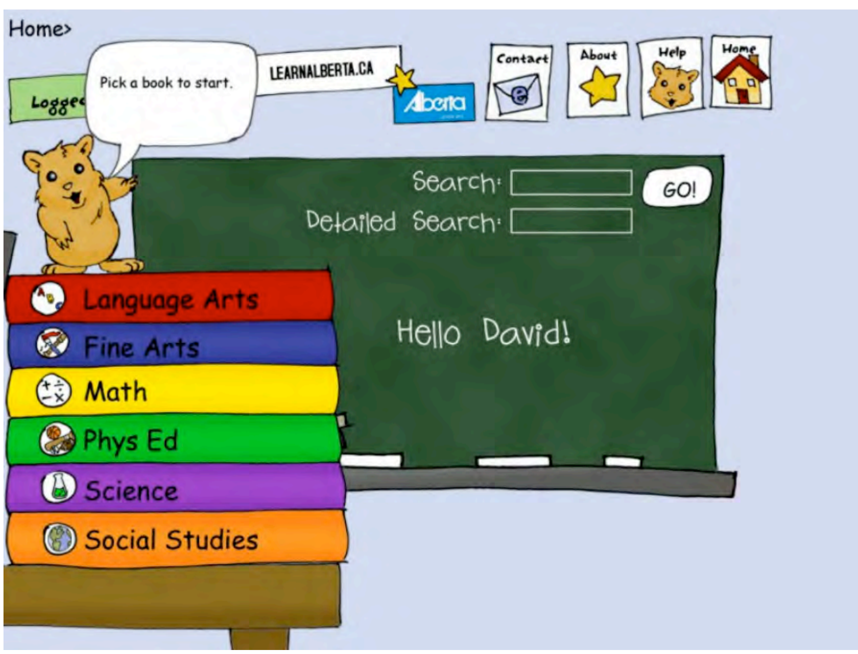


**Figure 9: Navigator/Help**

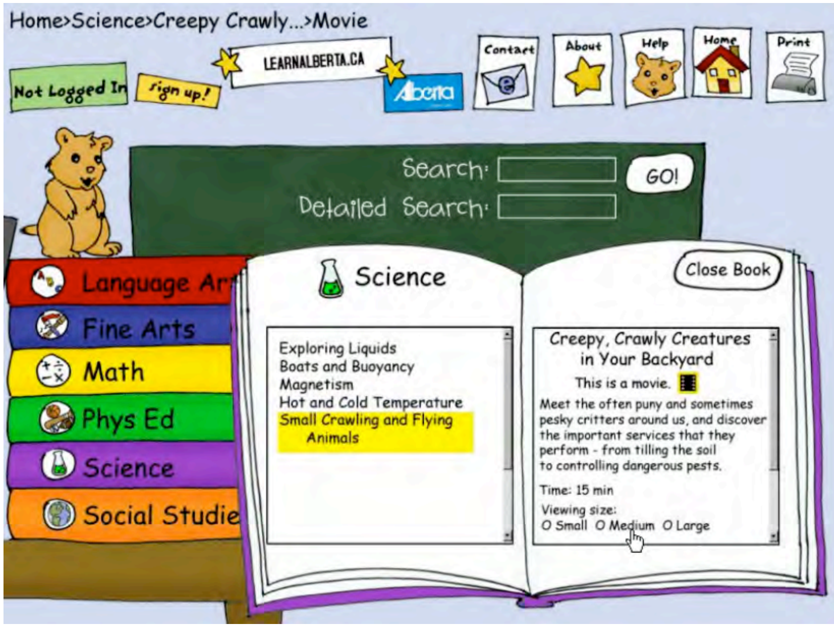


**Figure 10: Subject Browser**


**Figure 11: Viewing Screen**

### *5.6.6.1 Background*

Thirty-three students participated in the ViStA static interface testing sessions. The static interface questions are found in Appendix: Interface Evaluation Report.

- 13 students were in Kindergarten to Grade 3 (Division I).
- 9 students were in Grades 4 – 6 (Division II).
- 11 students were in Grades 7 – 9 (Division III).

The video "Creepy, Crawly Creatures in Your Backyard" was chosen by the indexer for testing.

### *5.6.6.2 Summary for Kindergarten to Grade 3*

Thirteen students participated in the usability testing of the static interface. These included an ad hoc group at the Devonian Building, Edmonton, and a group at Alexander Forbes School in Grande Prairie.

#### *5.6.6.2.1 Recommendations*

- The majority of the students appeared to like the site and thought they would use it for their homework.
- They especially seemed to like the cartoon character, which they hope to have present at all times, along with audible directions for the younger students learning to read.
- The videos were a popular feature.
- Based on student feedback, it is recommended that primary colors be used throughout the web site, along with matching images / pictures to describe the icons.
- The most confusing elements of the web site seemed to be the function of the detailed search and the navigation of the login screen. To avoid this confusion with Kindergarten to Grade 3 students, the detailed search could be omitted and the navigation of the login screen could include fewer elements.
- Easier terminology should be used for the navigation menus. Specifically such terms as Language Arts, Buoyancy, and Magnetism should be avoided and replaced by terms that the younger students in kindergarten to Grade 3 can understand.
- Most of the children preferred the use of primary colours.

### *5.6.6.3 Summary for Grades 4 - 6*

Nine students participated in the usability testing of the static interface at the Devonian Building, Edmonton.

A major problem associated with this testing were technical difficulties experienced during the viewing of the video. The video was pixilated, blurry, slow to download and distorted at times.

#### *5.6.6.3.1 Recommendations*

- The cartoon character that seems to appeal to younger children is too childish for this age group. It should, therefore, be replaced with an icon/character that Grade 4 - 6 students can relate to. A suggestion would be to look at some of their favorite web sites to identify possible alternative characters.

- Overall the terminology used for the web site seemed appropriate. Students suggested replacing the terms like "Fine Arts" and "Phys. Ed" with "Art" and "Gym."
- The function of most of the buttons seemed clear to students. There was some confusion around the About and Contact icons, which could be avoided by finding more suitable graphics to place on the buttons. The detailed search was another confusing element for this age group. This function could be clarified by including an example under the text field and a brief description of what it does.
- With regards to colours and fonts, students preferred a variety of colours and larger fonts like the ones used for "I Am In", "Login Here", "Name" and "Go."
- The Grade 4 – 6 students preferred using the QuickTime controls instead of the rewind button on the video page.

#### *5.6.6.4 Summary for Grades 7 - 9*

Eleven students in an ad hoc group at the Devonian Building, Edmonton participated in the usability testing of the static interface.

##### *5.6.6.4.1 Recommendations on the Kindergarten to Grade 3 Interface*

Students from the Grade 7–9 division were asked to respond to the web site interface developed for the younger students. They expressed what they believed to be the preferences of Grade 2 students to the interface:

- Use a left navigation bar with graphic identifiers/buttons rather than simple text links.
- Overall, students suggested that brighter colors and larger icons should be used with more "white space."
- Most students thought that some of the terms were too advanced and suggested replacing terms like "Fine Arts" and "Phys. Ed" with "Art" and "Gym." They also thought that large amounts of text, such as the text that appears beside the video links, should be larger and double-spaced, so it is easier to read.

#### *5.6.6.5 Recommendations from the Comparison of Four Grade 7 - 9 Web Sites*

The following recommendations were obtained from Grade 7 - 9 students reviewing four web sites:

- When designing the web site for Grade 7 - 9 students, a *vertical layout* (Figure 12) would be preferable, as the majority of students liked it more than a horizontal or random layout.

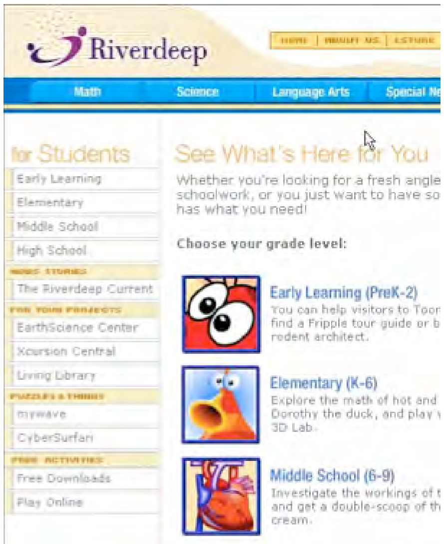


**Figure 12: Left Vertical Layout**
http://www.riverdeep.com/for_students (link not available)

- Students also indicated a strong preference for text links and a navigation menu that is on the left-hand side of the page (Figure 13).

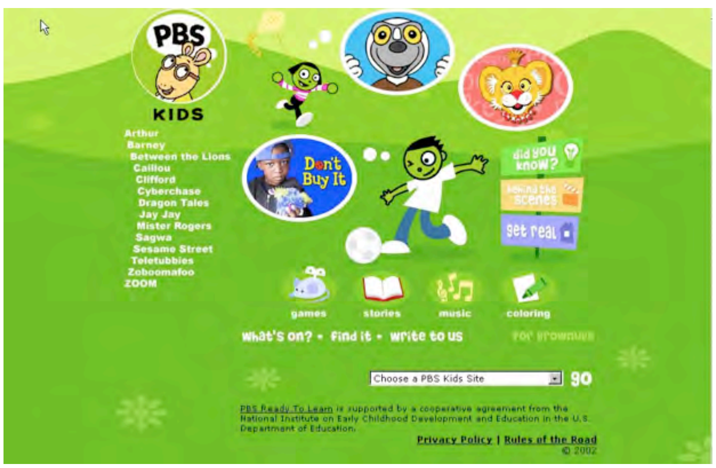


**Figure 13: Left Text and Random Links**
http://www.pbskids.org

- For the overall web site layout, it is suggested that *bright links* be used like the ones in the BBC web site (Figure 14). Headings with short descriptions are also recommended similar to the ones used in the Riverdeep web site (Figure 12).

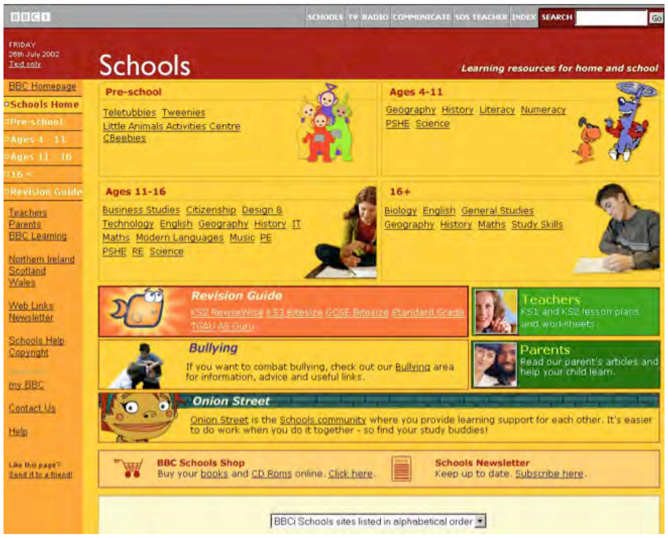


**Figure 14: Mix of Text Links**
http:// www.bbc.co.uk/schools

### 5.6.7 Dynamic (Interactive) Interface Data Student Summary


**Figure 15: Dynamic Interface**
http://commons.ucalgary.ca/cgi-bin/WebObjects/ViStA

#### *5.6.7.1 Background*

Several issues had a significant impact on this evaluation process:

- Network traffic slowed the download of videos to the desktop to unacceptably poor levels and accounted for great packet loss.
- Viewing windows for the videos could not be resized throughout the testing period. All screens (small, medium and large) remained in the smallest size.
- Although the evaluation team prepared to do a comparison test between QuickTime and Windows ASF formats, all testing was conducted using QuickTime due to technical and logistical difficulties.
- No “real world” test was conducted over SuperNet as the technical infrastructure was not in place during the timelines of the ViStA Project.

In total, 38 students in Grades 7 - 9 participated in the ViStA dynamic interface testing sessions. PCs, Macintoshes, and Macintosh laptop computers were used in the evaluation testing.

- 14 students were from Grande Prairie.
- 13 students were from Innisfail.
- 9 students were from Calgary.

The grade distribution of the students was:

- 6 students were in Grade 7.
- 8 students were in Grade 8.
- 24 students were in Grade 9.

The dynamic interface questions are found in Appendix: Interface Evaluation Report.

#### *5.6.7.2 Summary*

Although these tests encountered technical difficulties, students did make a number of pertinent observations and recommendations:

- Overall the students appeared to like the interface. They particularly liked the main page, including the grade headers, fonts, images, and overall layout of the page.
- The page needs a variety of colors and graphics on the pages, as many of the students thought that there was too much green on the content pages, which made the pages look dull and empty.
- Generally, the font sizes were easy to read throughout the site. However, the font used for the date, welcome message, and description of the videos could be larger and more clearer.
- Within the content pages, the structure of the grade and subject links should be modified. Many of the students seemed confused about the content that would appear under each link.
- Overall the video quality was inadequate. Due to technical failure, the video screen size was the same (small) in all three versions of the testing. Only half of the students thought the screen size was large enough.

- Better quality videos with bright colors and clear audio should be used for streaming purposes.
- Generally, download times were unacceptable (too slow).
- Most of the students found the terms Low Bandwidth and Broadband and the film icon very confusing and were not sure of their meaning. The words need to be replaced with simpler words like “Large” and “Medium” size.
- The film icon needs to be much larger to ensure that the students understand its meaning and purpose.
- Pedagogical issues were introduced. Most students thought they would use the site to help them with their homework.
- The majority of the students preferred to read the introduction online. A smaller number of students preferred an introduction from the teacher followed by reading it online
- 65% of the students thought that the video clip, a two minute segment from the middle of the video (Figure 16), was informative and could stand alone as an instructional tool.

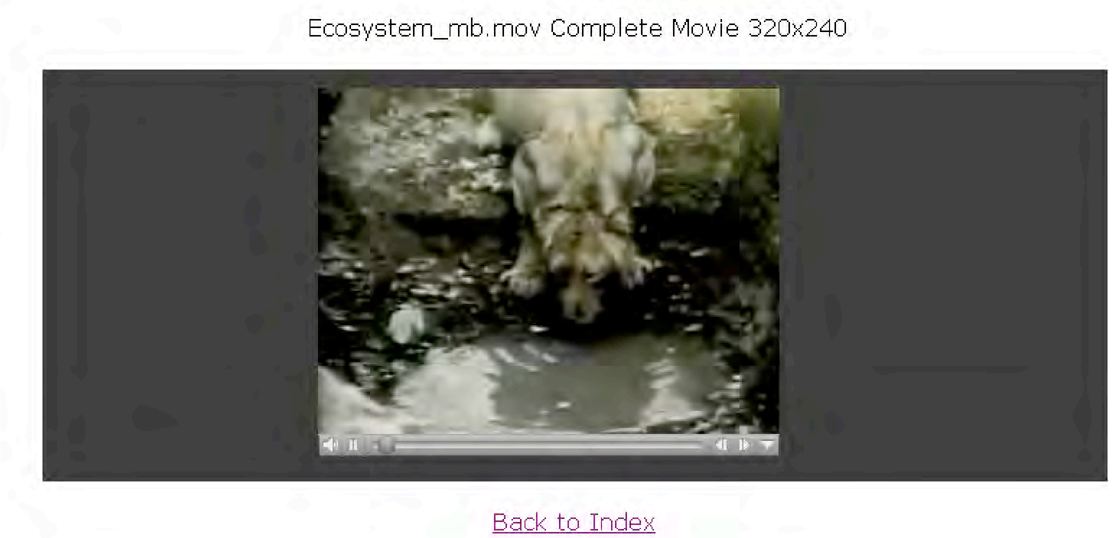


**Figure 16: Video Segment**

### 5.6.8 Dynamic (Interactive) Interface Data Teacher Summary

#### *5.6.8.1 Background*

Eight junior high teachers participated in the dynamic interface testing sessions. Most teachers taught Grade 7 science and one teacher taught art and one taught industrial arts. The testing questions are found in Appendix: Interface Evaluation Report.

- 3 teachers were from Grand Prairie--Alexander Forbes School.
- 2 teachers were from Innisfail--Innisfail Junior High School.
- 3 teachers were from Calgary--Tom Baines Junior High School.

#### *5.6.8.2 Summary*

Identical issues of network traffic and screen sizing affected the teachers as well as the students during evaluation of the dynamic interface. Most of the teachers were not familiar with the ViStA dynamic interface when the testing began. These teachers made the following observations and recommendations:

- The most important feature of the site was the teacher icon. Teachers had high expectations in terms of support and resources. They expected to find a wide variety of teaching resources. (e.g., lesson plans, web site links, Q & A section, where to turn to for help using the site, sharing ideas via a discussion board, how to incorporate the videos into the curriculum, etc.).
- The teachers were very excited and curious to learn more about the project and digital learning objects.
- Teachers cited that the biggest barrier to using the site was not having enough access/time to the computer labs.
- The term Broadband was not fully understood by the teachers and it was suggested that the terms Small, Medium and Large be used to describe the video formats.
- Upon initial consultation, teachers appear to be open to the idea of using the video streaming site as an enrichment tool.
- The teachers believed that they would feel more confident implementing video streaming after a brief tutorial or demonstration of how the site works and how video streaming could be incorporated into lesson plans in order to enrich the curriculum.
- Unlike the students, 60% of the teachers thought that the video clip (2 minute segment from the middle of the video presentation) was unacceptable as a stand-alone instructional tool. They thought that the clip required more introduction and context. They stated that the video clip would be useful as a follow-up tool to the main lesson.
- 50% of the teachers thought that the video learning resources would save them time in developing curriculum.

## 5.7 NETWORK

### 5.7.1 Objective

The key objective of the network component of ViStA was to test video streaming over a high-speed network from the source to the desktop or classroom.

### 5.7.2 Background and Test Plan

The network delivery component of ViStA arose from a Physics video streaming pilot that identified a need for further investigation of video streaming: *"Huge issues accompany the use of digital video. Video streaming will require the investment of a* *great deal of time and energy and money. This is especially troublesome considering that we do not know how well the proposed delivery methods will work on a larger scale."*

The ViStA network tests were intended to be quantitative, that is, focused on network performance and bandwidth. A test plan was developed in collaboration with various school jurisdictions pending completion of SuperNet Segment 7 (a pilot section of the SuperNet network). The planned test process included both benchmark testing and real world testing over SuperNet. Benchmark testing was defined as exclusive, controlled use of SuperNet with only the test video being streamed over the connection. Real world testing was defined as video streaming over the same connection but with other applications using it simultaneously.

A packet capture software package, "EtherPeek" (http://www.wildpackets.com/), was selected to measure network throughput in specific locations. The results of actual video tests on SuperNet were to be compared with results from other tests in either local or non-SuperNet environments.

The quantitative tests would then be aligned with the subjective usability tests of the user interface group. If time permitted, the test results would be correlated with similar testing done as part of the SuperNet Segment 7 acceptance testing.

It was not possible to fully implement the testing plan because SuperNet Segment 7 was not available as anticipated. See Section 5.7.4 for Recommended (Future) Network Tests.

Network testing was attempted in July 2002 between servers at the Netera server farm in Calgary and the Alberta Learning facilities in Edmonton. This was not successful due to the intensive bandwidth congestion that was encountered on the Internet links.

### 5.7.3 Completed Network Tests

Two sessions of tests were conducted over SuperNet Segment 7 to H.J. Cody High School in Sylvan Lake, Alberta. Test Session #1 (comprised of 6 tests) was conducted on December 1, 2003 and Test Session #2 (comprised of 3 tests) was conducted on March 20, 2003.

The following diagram represents a high level view of the network flow from the school desktop to the streaming of the video through SuperNet and including CAREO digital repository and indexing interaction.

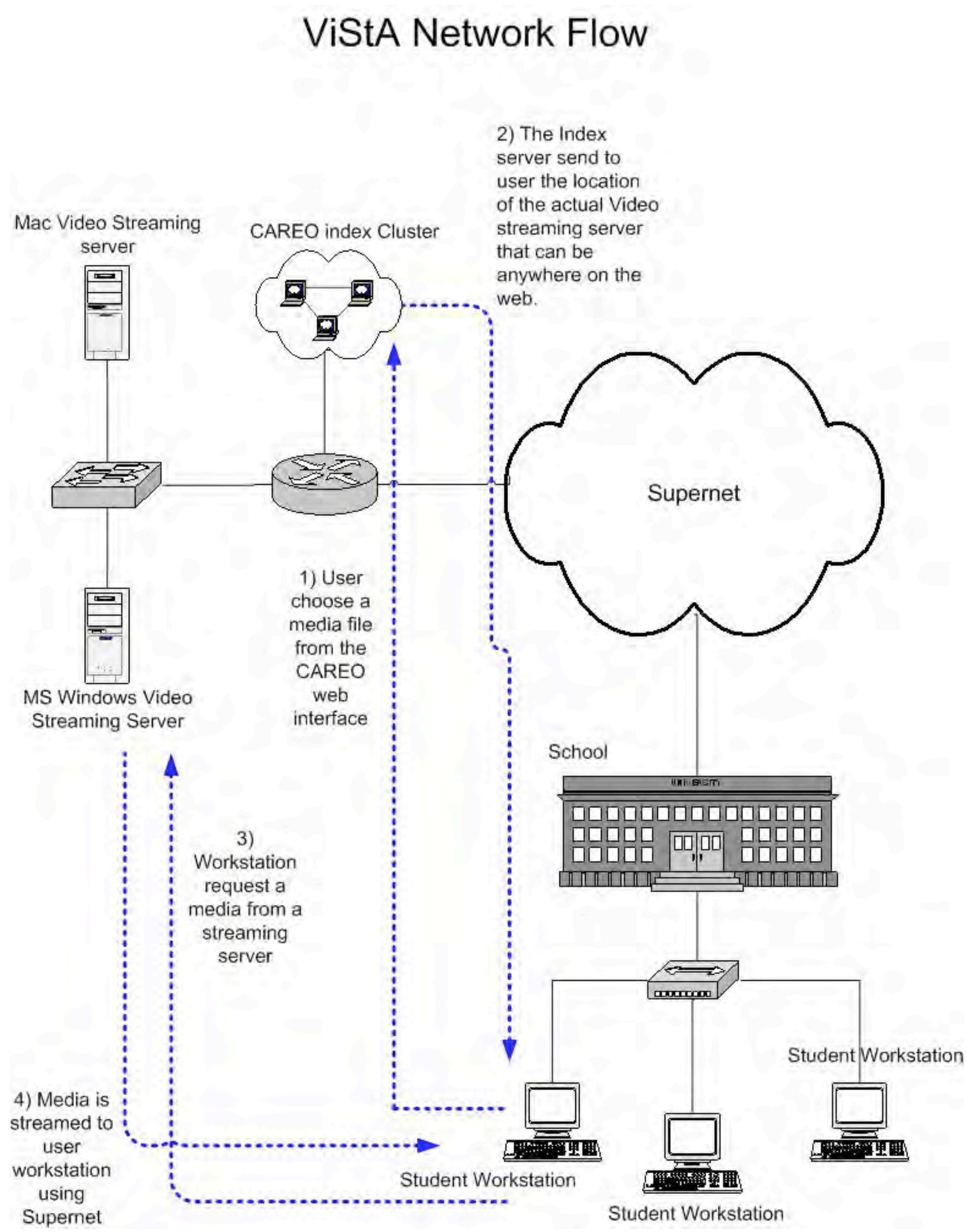


**Figure 177: ViStA Network Flow**

### *5.7.3.1 Issues*

Prior to Test Sessions, preliminary SuperNet tests (October and November 2002) identified configuration problems in various network switches:

- Ethernet switch configured improperly (half/full duplex mismatch). Transfer of a large file used to test the connection.
- Tests with a Unix based computer used as a local router at the school.

These initial problems were overcome prior to Test Session #1 and Test Session #2.

The overall benefit of the MPLS burst value could not be derived from the Test Sessions. This burst value acts as a buffer that allows for a brief (5 second) extension over allowed bandwidth. Benefit from the burst value is only apparent in the first 5-10 seconds. Therefore, the burst value significantly impacts a short video clip, but has little impact on a longer video. The MPLS burst value did not significantly impact the overall results because longer (two-minute) videos were used. Note: At the time of testing, the MPLS burst value was not set. The SuperNet partners proposed a MPLS burst value on March 24, 2003.

Real world tests were not possible due to the following:

- No typical or standard jurisdictional or Internet traffic was flowing through SuperNet.
- The MPLS VPN architecture with service level was not fully implemented.

#### *5.7.3.2 Test Session #1 Results*

Six tests were completed during this session. The following chart summarizes the results of each test.

| Test | Sample | Average Utilization (Kbits/s) | Total (Bytes) |
|---|---|---|---|
| Test #1 | Sample a | 820.670 | 12 267 083 |
| | Sample b | 693.472 | 10 375 200 |
| | Sample c | 702.518 | 10 468 300 |
| Test #2 | Sample a | 21.858 | 107 081 |
| | Sample b | 13.970 | 93 695 |
| | Sample c | 19.268 | 77 227 |
| Test #3 | Sample a | 1075.113 | 1 399 401 |
| | Sample b | 1053.575 | 1 363 507 |
| | Sample c | 1126.940 | 1 457 813 |
| Test #4 | Sample a | 710.346 | 10 598 113 |
| | Sample b | 733.025 | 10 951 079 |
| | Sample c | 751.481 | 11 228 321 |
| Test #5 | Sample a | 619.623 | 9 272 231 |
| | Sample b | 602.762 | 9 040 107 |
| | Sample c | 652.698 | 9 782 137 |
| Test #6 | Sample a | 798.218 | 11 944 079 |
| | Sample b | 811.678 | 12 148 598 |

**Figure 188: Test Session #1 Results**

The objective of each test is described below:

**Test #1: Determine the bandwidth requirements for a single video stream to a single computer.** (This value may be used to forecast the bandwidth requirement for a given number of computers.)

- A typical stream carrying a 320 x 240 at 30 fps QuickTime movie requires approximately 700 Kbps.
- The data volume of the first sample is slightly higher due to the buffering of video data into the client computer.

**Test #2: Determine the video management infrastructure (CAREO) traffic levels.**

- The network traffic generated by access to the video management infrastructure (CAREO) is insignificant when compared to the bandwidth required by a video stream.

- CAREO adds a one-time bandwidth access requirement of between 77 – 107 KB to stream video for two minutes.

**Test #3: Determine how bandwidth requirement is affected by caching.**

- The first minute or so of a video stream requires more bandwidth to establish the connection and fill the local cache.

- At an average of 1,100 Kbps, the requirement for video buffering is significant: 53% higher than average streaming at 700 Kbps. This increase occurs for less than 10 seconds at the start of the movie. In the event that this bandwidth requirement could not be satisfied, the buffering process would take slightly longer.

**Test #4: Compare bandwidth requirements of UDP and TCP streaming methods.**

- A 4% difference was observed (using HTTP as the transport protocol) between streaming QuickTime at 700 Kbps and streaming Microsoft Media at 733 Kbps. This difference is not considered significant.

- Generally, UDP is the protocol of choice for video streaming. This test compares only the bandwidth requirement, not any other attribute inherent to the transport protocol.

**Test #5: Determine if there is a difference between QuickTime and Windows Media streaming technologies on a bandwidth requirement basis.** (See following chart.)

- A movie with identical attributes was used to create a QuickTime and Windows Media streaming video. The average bandwidth utilization for QuickTime was approximately 700 Kbps and for Windows Media was approximately 600 Kbps. QuickTime required about 17% more bandwidth to stream a comparable attribute movie.

- The packet size distribution between QuickTime and Windows Media is slightly different. Windows media appears to utilize larger packets. Note: The QuickTime .MOV file was larger because of the hint track that is built-in into the file. This is a requirement of QuickTime streaming servers to improve video output quality.

| Packet Size Distribution | | | | |
|---|---|---|---|---|
| Size | | For Windows Media | | For QuickTime |
| <= 64 | - | 0.00% | - | 1.13% |
| 65-127 | - | 0.00% | - | 17.37% |
| 128-255 | - | 0.02% | - | 3.61% |
| 256-511 | - | 0.02% | - | 5.86% |
| 512-1023 | - | 16.63% | - | 12.67% |
| 1024-1517 | - | 0.02% | - | 59.36% |
| >= 1518 | - | 83.33% | - | 0.00% |

**Figure 199: Windows Media vs. QuickTime**

**Test #6: Compare bandwidth requirement between a stream with animation (cartoon style) imagery and a normal stream of video images with more colour tones (derived from the same movie).**

- The variation in this case less than 2%. No conclusion about the type of animation or complexity of the image making any important difference to the bandwidth required can be made from this test.

### *5.7.3.3 Test Session #2 Results*

Tests were completed over two levels (5MB/sec and 10MB/sec) of SuperNet connection.

| | | | | | |
|---|---|---|---|---|---|
| **5MB/sec Supernet** | | | | | |
| FTP | 39,767,786 | 2,660 | 2:00 | 2035 | N/A |
| FTP | 43,103,485 | 2,878 | 2:00 | 2140 | N/A |
| 1 movie | 11,153,557 | 746 | 2:00 | 0 | Excellent |
| 6 Movies | 68,032,844 | 4,563 | 2:00 | 106 | Very good |
| 6 Movies | 59,675,910 | 3,993 | 2:00 | 87 | Very good |
| 7 Movies | 66,618,115 | 4,453 | 2:00 | 689 | Good |
| 7 Movies | 74,324,984 | 4,909 | 2:00 | 614 | Good |
| 8 Movies | 73,252,892 | 4,901 | 2:00 | 1725 | Some freeze |
| 9 Movies | 75,371,429 | 5,042 | 2:00 | 1982 | Freeze |
| 9 Movies | 65,698,909 | 4,395 | 2:00 | 1712 | Freeze |
| 6 cbr Movie | 62,493,207 | 4,174 | 2:00 | 1215 | Extended freeze |
| 1 cbr Movie | 21,857,550 | 1,459 | 2:00 | 1 | Excellent |
| 1 cbr Movie | 23,533,344 | 1,573 | 2:00 | 0 | Excellent |
| 1 vbr Movie | 11,460,755 | 1,525 | 2:00 | 0 | Excellent |
| 1 vbr Movie | 10,379,270 | 1,380 | 2:00 | 0 | Excellent |
| 3 cbr Movie | 60,950,429 | 4,074 | 2:00 | 492 | Good |
| **10 MB/sec Supernet** | | | | | |
| 9 Movies | 94,315,024 | 6,311 | 2:00 | 628 | Very good |
| 4 CBR | 83,081,851 | 5,555 | 2:00 | 23 | Good |
| 5 CBR | 112,319,326 | 7,516 | 2:00 | 113 | Good |
| 6 CBR | 130,479,321 | 9,069 | 2:00 | 883 | Good |
| 7 CBR | 136,050,646 | 9,090 | 2:00 | 1301 | Some freeze |
| 8 CBR | 139,368,726 | 9,291 | 2:00 | 1560 | Freeze |
| FTP | 117,738,039 | 7,888 | 2:00 | 2486 | N/A |

**Figure 20: Test Session #2 Results**

Up to nine movies were streamed concurrently on both the 5 Mbps and 10 Mbps links to determine at what threshold the quality of the video stream began to degrade. When packet loss due to congestion exceeded 2%, the user experience began to seriously degrade. In terms of number of streams, seven 700 Kbps movie streams utilized an average of 4900 Kbps (4.9 Mbps). This is near the upper limit for a SuperNet 5 Mbps link. Each FTP transfer utilized an average of 2600 to 2800 Kbps. According to the SuperNet contractor, this small throughput was due to the MPLS burst setting that was not optimized for large single user data transfer.

A 1500 Kbps movie was streamed on a 10 Mbps link. Since there were only nine computers available at the school, a higher bandwidth movie was required to approach 10 Mbps with up to nine streams. The threshold in this case was found to be six streams for a total of 9.068 Mbps.  An FTP download on the same link yielded an average transfer rate of 7.887 Mbps.

When the number of streams exceeded the WAN capacity, exponential packet loss resulted and many out-of-sequence packets occurred due to forced retransmission.

Fixed or variable bit rate does not appear to make a difference in average bandwidth requirements (1458 Kbps CBR vs. 1525 Kbps for VBR).  Significant differences in the way the traffic is shaped were apparent. See following charts.

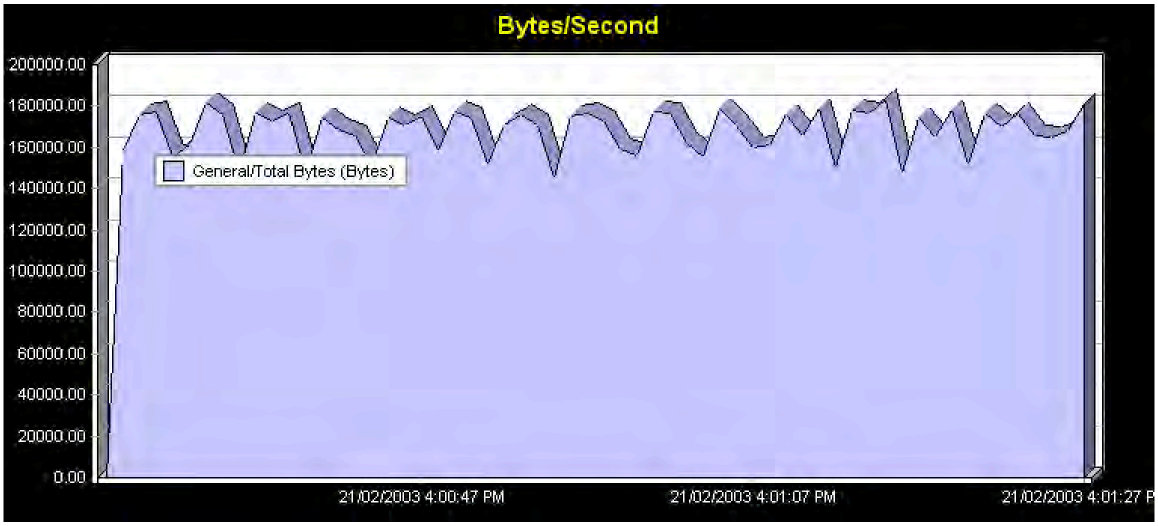


**Figure 21: Traffic distribution of CBR vs. VBR media: CBR Sample**

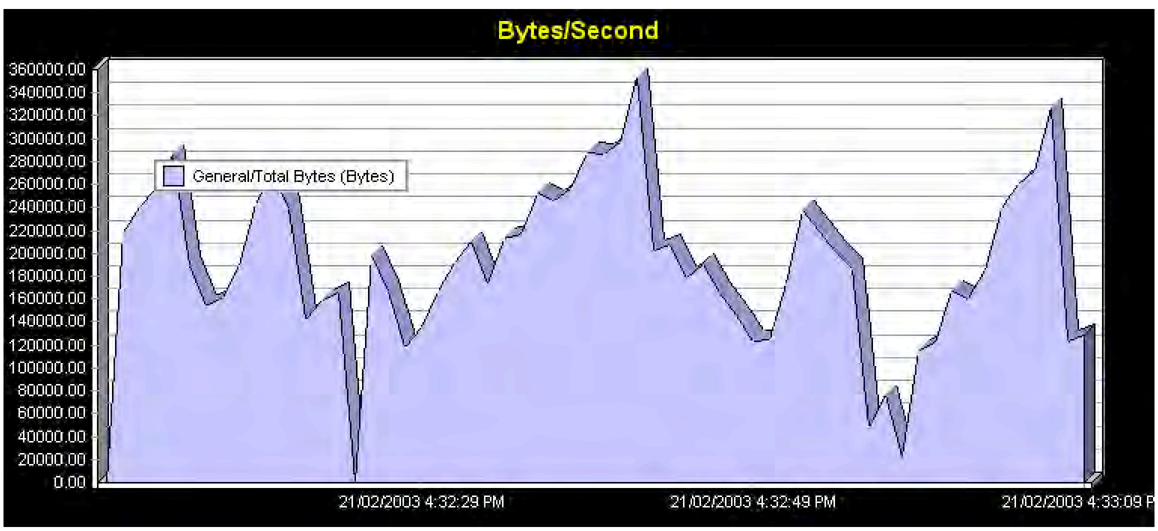


**Figure 22 Traffic distribution of CBR vs. VBR media: VBR Sample**

### 5.7.4 Recommended (Future) Network Tests

The following tests are recommended to complete the original plan for the network component of ViStA.

***Caching Device***
Stream video over SuperNet to a school jurisdiction employing a caching device to determine:

- if the bandwidth requirements were linear with the number of video streams
- the impact on WAN bandwidth if a movie is repeated (i.e., stored on local cache server). Verify if bandwidth is required for the replay.
- the maximum number of clients that can access the caching device.

***Hardware***
Test client hardware components including computers, servers and caching servers to determine:

- which hardware component(s) create a bottleneck
- differences between older computers and newer, high-end computers. (Double the number of streams and monitor the effect on CPU/memory/IO/disk on a server/workstation.)

Note: SuperNet access is not a requirement for this test.

***Video Quality***
Determine the level at which usability becomes an issue by detailed testing on mid-range bandwidth utilizing both constant bit rate (CBR) and variable bit rate (VBR) video encoding at 400 Kbps, 500 Kbps, and 600 Kbps.

***Network Devices***
Build a pilot with a firewall, proxy, NAT device and cache. Determine the interoperability of network devices to stream video to the client computer rather than focusing on any single technical component.

***Local Infrastructure***
Determine the ability of a school local area network, and selected local hardware platforms to handle the traffic load in addition to its daily network LAN traffic.

***Virtual Private Network (VPN)***
Determine the ability of SuperNet to provide a VPN and how best ViStA could benefit from this feature (PVC style mapping security versus Firewall security).

### 5.7.5 Conclusions

While it is too early to draw final conclusions on the feasibility of streaming quality video to schools, early test results were encouraging. Streaming video on SuperNet can work well.

SuperNet may not be able to meet all bandwidth requirements for video streaming. These test results indicate that a video stream of a good quality movie (320 x 240 at 30 fps) streams at approximately 700 Kbps. Since the typical school will receive a 5 Mbps link to SuperNet, one can predict a maximum of 7 concurrent video streams and 14 streams on a 10 Mbps link before viewing quality deteriorates. While the test was not completed, caching solutions should help alleviate bandwidth requirements.

This phase of the project confirmed the ability of SuperNet at its current stage of deployment to carry moderate-sized streams of real-time traffic between widely separated locations. It is often not possible for a school to receive a jitter-free 700 Kbps video stream via an Internet service provider, so the early capabilities of SuperNet appear positive.

ViStA testing over SuperNet was conducted in an environment of very light network traffic; the results can only describe the extent to which SuperNet meets the performance expected of the network's design. Tests performed at this stage of the SuperNet deployment cannot be used to accurately predict the network's behaviour when the load factor is substantially higher.

## 5.8 Student video resources

### 5.8.1 Definition

Although beyond the scope of this project, this section discusses the active use of video creation resources in the classroom. A history of the small implementation steps already taken, as well as recommendations on the steps required for the successful use of video resources in the classroom is provided.

### 5.8.2 Background

Tom Baines School in Calgary was selected location for the installation and testing of a QuickTime Streaming Server. Apple Computers and the Information Systems department of the Calgary Board of Education supported the school installation. iMovie software was used due to staff and student familiarity with this tool and with the Macintosh hardware. Other excellent tools for video editing are available.

The goal was not the learning of the video editing but learning to communicate well using multimedia and video. One benefit of using any video editing software is that it allows learners to build or construct knowledge using a medium that is both effective and motivational.

The original plans were to use the commercial video editing software provided by the project and to develop video by both students and teachers for use in the project. The commercial content was provided to the school in September 2002. The school decided to focus their "in-school" video development in science to further utilize the commercial video content.

In March 2002, Apple Computers installed a QuickTime Streaming Server (QTSS) for project use. The Calgary Board of Education server support staff was also on site to document the installation for future use in other schools using streaming servers.

Students produced about twenty video segments that were converted to streaming format and placed on the QuickTime Streaming Server (QTSS). The clips are being used as student work examples in the school's Computer and Technology Study (CTS) options. The streaming video segments were developed by CTS, drama and science students.

The school also created a web site on an internal web server to provide staff and students with access to the content provided by the ViStA project as well as the content created by the students  The web site also provided information about video streaming as well as a progressive download version of streamed video.

### 5.8.3 Best Practices

#### *5.8.3.1 Document for the Creation of QuickTime Streaming Data*

Simple, easy-to-use instructions were developed for teachers and student on how to create QuickTime streaming video and make that content available as learning objects. Students could then incorporate those learning object into their own projects.  The final document consisted of:

- Steps for creating streaming QuickTime video.
- Instructions for using iMovie 2 and other editing software.
- Explanations of different file attributes for different applications
- Instructions on the use of Cleaner 6 and iMovie 2 to create custom streaming video.
- Tips on how to create successful streaming video.

#### *5.8.3.3 Video Cameras*

Original video footage was captured on Sony TRV 110/120 and Canon ZR 10/40 digital video cameras in both the Digital 8 and MiniDV formats.  No significant camera differences were seen.  The MiniDV format cameras are smaller and had a longer battery life.  When using the Digital 8 format cameras, it was found that professional grade 60-minute tapes (these provide only 30 minutes of digital video) were best since they put less demand on the camera's motors.

#### *5.8.3.4 Video Capture*

The Macintosh platform was used for all of the video capture.  Transfer to the Macintosh occurs from the camera via FireWire (IEEE 1392) using the iMovie 2 software by Apple. Students and staff found it necessary to use Final Cut Pro 2 software in place of iMovie 2 due to some of the different features available in Final Cut that were not available in iMovie.  Overall, they found that iMovie 2 had a short learning curve allowing students and teachers to begin production of video projects quickly.  Forty-five minutes of instruction was required for most users to produce their first project.

Students and teachers recommend that whatever video editing software is used, it should:

- Import video via FireWire from digital cameras.
- Edit video in a simple easy-to-use graphical interface.
- Include transitions, sound effects and imported music from CDs and other digital formats.
- Integrate narration.
- Have at least one video track and two sound tracks.
- Output back to the video camera via FireWire.
- Output to other digital formats that can be re-purposed when needed (i.e., QuickTime, Real, etc.).

#### *5.8.3.5 Video Sizing and Formatting*

The success of video streaming is based on a number of variables, some of that can be controlled while others can not. Some variables that can be controlled relate to physical attributes and settings of QuickTime files. Staff and students found that QuickTime streamed video could be produced two ways. The first was to use iMovie 2 only and use the default setting for streamed video in the export engine of the software. This produced a QuickTime streaming video that would work on a streaming server every time, though not necessarily perfectly for every network or workstation configuration.

The second method involved using iMovie 2 in combination with the post edit program Cleaner 6 by Discreet. This method required higher levels of knowledge and understanding of QuickTime file formats but allowed for the creation of QuickTime streaming video that would fit any network or workstation configuration.

Staff and students produced video in iMovie 2 and then exported it to DV format or whatever was the largest format possible in the preset settings in iMovie 2. This video was then imported into Cleaner 6, which allowed the editing of various characteristics of the movie (i.e., size, streaming rate, frame rate, etc.). Cleaner permitted the staff and students to successfully create streaming video to various computer configurations. These included computers from IEEE 802.11b wireless network connected computers through legacy 1997 computers running at 160 MHz.

#### *5.8.3.6 Creating "Learning Objects" from QuickTime Streaming Video*

Once a streaming video clip was moved onto a QuickTime streaming server, a number of different methods were used to access the clip depending on a user's objectives. Students tended to access the clip from web pages where the learning objects were linked. The videos were either embedded in a web page or within the QuickTime Player application. Students also accessed the video using the QuickTime Pro version of the player.

QuickTime Pro is the authoring version of QuickTime and is required to create learning objects. Files created using QuickTime Pro can be used within other applications that link the smaller video files to larger streaming videos located on the streaming server.

These smaller files can be embedded within PowerPoint, Word, HyperStudio, web pages or other applications that have video integration capability.

#### *5.8.3.7 The Learning Curve*

Students and found that each component had varying “learning curves.” Some applications and processes were easier to learn than others as described below.

<u>Server Setup</u>

The learning curve to set up a QuickTime streaming server, the learning curve is not step if the server retains its default settings. It would be feasible for a school district to develop a set of standard server settings that would meet the needs of most situations and environments. The time to set up the server was approximately one hour.

<u>Camera and Basic Software for Video Capture</u>

The time required to take a student/teacher from knowing little about digital video to being able to produce a simple three-minute video clip required about two class periods.

<u>Creating QuickTime Steaming Video with Advanced Tools</u>

The average classroom teacher will likely need more training/learning in order to create video for a streaming server. Software like Cleaner 6 or Sorenson Squeeze offer many technical choices when creating video and many of these choices require some background knowledge in order to make informed decisions.

<u>Creating Learning Objects with QuickTime Pro</u>

Teachers and students required approximately one-hour to learn how to use QuickTime Pro to create QuickTime learning objects. Staff are currently developing the step-by-step instructions for this process

<u>Pedagogical Reasoning for the use of Streaming Video</u>

Digital video has all of the benefits of other forms of video including: increased retention of concepts and information, thinking and problem solving are facilitated, and it can be used to communicate facts and demonstrate procedures. Beyond these benefits, students can interact with the video or design a video presentation that can include the video and other resources.

The use of streaming video in the learning environment supports a shift in pedagogy from a transmission model to the constructivist model to the collaboration model where control of the learning resources lie in the hands of the students. The student has an opportunity to work with resources that are interactive and that they can integrate into their work. When images (video or digital stills) are combined with interactivity into a well-designed student interface, students are “on task” for longer periods of time. As a result they tend to retain more of the concepts than with conventional learning resources.

Combining streaming video with well-designed user interfaces can result in a more successful learning environment. There is a belief that students will be more successful using an interface that has more than one type of media on it. One study called this multiple channel communications or dual code theory (Hasia, 1971). In this case images, text and streaming video were combined in a way that allowed users to interact and make choices.

Streaming video tends to be in shorter segments than traditional video. This suits the multiple channel design and supports the belief that people have a short attention span when looking at content on a computer screen. To improve bandwidth utilization much of the streaming video is reduced in screen size so that it can fit into the multiple-channel user interfaces. Streaming video can be presented in an HTML environment, within a presentation interface like Microsoft PowerPoint, HyperStudio, Ezedia, Macromedia Director or other multimedia interface.

Another use of content segments a longer streaming video into a new multimedia user interface. Students or teachers would create learning objects that are embedded in their presentation interface. Creation of these learning objects must be easy to do, segmented while preserving the original full footage, and final segments creating little or no load on the network or servers.

Studies (Buzan 1997) have shown that visual images are remembered at an extremely high rate. Web technology and the use of SMIL (Synchronized Multimedia Integration Language) files permit a streaming video to play with action and sound as well as having text information presented on the same web page that changes to match video content.

### *5.8.3.8 Recommendations for Future Investigation*

Digital content in the form of streamed video is in demand in the classroom and in virtual school environments. VCRs and videotapes are going the way of the film projector and film on a reel. Educators are expected to use computers to meet outcomes outlined in the Alberta Program of Studies. Teachers want to use computers mainly because of the increasing pool of fine digital resources and partly because other resources are disappearing.

For staff and students to make effective use of digital video in the classroom, it has to be accessible. Accessible implies more than “reliable playback on a computer screen.” To make effective use of video in large group situations requires high quality video that can be projected.

Students who miss presentations should have digital video available during non-classroom hours over a LAN, WAN or Internet.

What other priorities do teachers cite with regard to the use of digital video? Teachers suggest (in order of priority) that:

1: Digital video content should be easily customizable.

Rationale: As the designers of instruction, teachers must be able to segment or create pointers to parts of a larger digital video resource (i.e., knowledge object). Teachers wish to utilize specific parts of the content as needed.

2: Digital video content should be capable of being embedded in a learning context.

Rationale: Once segments or pointers to parts of larger digital resources are made, the pieces of digital content (knowledge objects) must integrate into a lesson (learning object). The knowledge object must have more than a conceptual fit; it must play with a minimal number of clicks and with a minimal lag in response time.

3. Applied research that supports teacher use of online digital video best support use in different settings and with different users should be initiated. For example, how can online digital video best be used:
    - at home?
    - projected in the classroom?
    - integrated into the virtual classroom?
    - in wireless classrooms.
    - for hearing impaired students.

4. Other research priorities include answering questions such as:
    a. How can teacher and student-produced content best be supported?
    b. How can digital video segments correlated to Alberta learning outcomes best be used to support student learning?
    c. How can user control to play, pause, replay and queue the streaming video using a slider best be accommodated?
    d. How should video be indexed, meta-tagged and searchable based on its use by the primary intended audience?
    e. How video can be digitized and compressed to meet a variety of quality and bandwidth considerations?
    f. Digital video content should come with searchable transcripts.
    g. Digital video content should run on a system that allows for seamless integration and playback of student and teacher created digital video content.
    h. Digital video content should permit multiple language translations.
    i. Digital video content should permit closed captioning.

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# 6.0 Appendices

Glossary

ViStA Work Plan

Details of the Partnership Approach

Metadata Guidelines for LearnAlberta.ca

Literature Review

Video Streaming Technical Implementation Guide

Interface Evaluation Report

References